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Ecological-Economic Modeling
In the Cache River Basin:

The Challenge of Ecological-Economic
Modeling on a Watershed Basin --
A Potential Framework for Sustainable Development

Final Report

Submitted to
The Illinois Field Office of
The Nature Conservancy

By

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[e]Co-Principal Investigators
Southern Illinois University Carbondale
(Senior Authorship is not Assigned)

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EXECUTIVE SUMMARY

The Cache River watershed encompasses a 1,944 km^2 area of 5 southern Illinois counties (Alexander, Johnson, Massac, Pulaski, and Union). The watershed, located near the confluence of the Mississippi and Ohio Rivers is at the juncture of four physiographic provinces; Central Lowlands, Interior Low Plateau, Coastal Plain, and Ozark Plateau. Given the establishment of the Cache River bioreserve in parts of these counties and the need to assess the ecological and economic effects of changing land use patterns in and around the bioreserve, we developed a framework for integrating economic and ecological concerns in the formulation and evaluation of land use alternatives in a predominantly rural watershed. The challenges of economic development and natural community restoration in the Cache River bioreserve include (1) identifying in a diversified, although sparse, regional economy, economic development opportunities in the watershed that will replace or enhance economic activity after establishment of the bioreserve, and (2) proposing alternative land use scenarios outside the core area that are ecologically compatible with preservation of natural communities throughout the watershed.

The framework incorporates an evaluation of a bioreserve with a core area containing a critical ecological resource that must be protected and/or restored. For the Cache River bioreserve, this resource is wetland and forest communities within a 20,000 ha. core area where The Nature Conservancy, U.S.

Fish and Wildlife Service, Illinois Department of Conservation, and Ducks Unlimited Inc., are coordinating efforts to protect and restore natural ecological communities. Surrounding the core is a buffer area within which land uses have profound effects on the continued vitality of ecological resources in the core and the performance of the regional economy.

The bioreserve area is rich in threatened ecological resources but is located in an impoverished rural economy with few linkages with the surrounding region and minimal infrastructure. The unique and diverse plant and animal communities that remain in the Cache River watershed have led to the designation of 58 sites as Natural Areas by the Illinois Department of Conservation; and two sites have been designated as National Natural Landmarks by the U. S. Department of Interior. As many as 100 species of plants and animals on the Illinois threatened and endangered species list are known to occur within the watershed. The Cache River basin also supports 10 globally rare or endangered species and ecological communities.

Current threats to the ecological integrity of the Cache River ecosystem include: (1) loss and fragmentation of natural habitats for plants, fish, and wildlife; (2) dramatic alterations of the natural hydrologic regimes of stream systems and wetlands; (3) excessive upland erosion and sediment deposition in wetlands; (4) degradation of surface and ground water quality; and (5) land use and economic development activities that are incompatible with long-term maintenance of natural ecological systems.

Although the biodiversity of plant and animal life is high in the region, sustained economic viability of the area is threatened as evidenced by low per capita incomes, high unemployment rates, outmigration, and low rates of labor force participation. Between 1980 and 1990 human population declined 2.6 percent, with the population ending the decade with 61,867 persons. Only 37.1 percent of the region's population was in the labor force compared to the statewide average of 53 percent. In 1990, unemployment rates in each of the five counties exceeded the statewide average of 6.2 percent. On a county basis, per capita income in the area ranged from 50.8 to 71.4 percent of the statewide average.

Another characteristic of the region's economy is the proportion of personal earnings derived from different sources. The percentage of earnings from wages and salaries which reflect the strength and vitality of an economy ranged from 37.5 percent to 44.1 percent, considerably lower than the statewide average of 65.0 percent. At the other end of the spectrum, transfer payments as a proportion of total personal income ranged from 24.2 percent to 32.5 percent, considerably above the state average of 13.1 percent. Agriculture accounts for about 2.6 percent of the net personal income in the region. The data indicate a population and an economy that cannot be described as vibrant and growing. Rather, they portray a too real picture of poverty and dependence on government, social security, and other transfer payments.

Using the bioreserve concept, we integrated ecological analyses along with economic data and models to assess the ecological and economic impacts of three land use scenarios in the bioreserve. The first scenario consists of two closely linked parts; the estimation of the impact of shifting land use in the core area from agricultural production to the restoration of wetlands and other natural communities and production of attendant wildlife/recreational/ecological values. This change in land use incorporated the restoration of natural communities and the development of wildlife habitat within the core area. Additionally, we looked at changes in the recreational portion of the economy over a 15 year period. We estimated the economic impacts of the land use changes at five years, ten years, and fifteen years after the start of the project. This allowed us to account for the gradual acquisition of land within the core area and to account for a gradual increase in entrepreneurial activity by local business people. Greater entrepreneurial and business activity would result in a larger proportion of the demand for goods and services by visitors to the area being supplied locally. This would have positive benefits for the entire regional economy.

The second scenario was the replacement of cropland with filter strips along major tributaries of the Cache River. Under existing USDA policy (i.e., the Conservation Reserve Program), filter strips are 20 to 30 meter strips of permanent woody or herbaceous vegetation along riparian zones. Filter strips act to

reduce the levels of sediment, crop nutrients, pesticides, and other chemicals that are introduced from topographically higher cropland into stream systems. Filter strips can also potentially function to enhance the connectivity among nonagricultural land within the watershed. From an economic perspective, filter strips result in the substitution of grasses or trees for high-value row crops. Consequently, they may represent an economic cost for the area. There are 12,149 ha. of row crops that could be converted to filter strips in the watershed.

The third scenario we evaluated was converting highly erodible cropland from row crop production to forage. We anticipated that a portion of the increase in forage production would be used to support cattle production with the balance being sold as a cash crop. The Conservation Reserve Program (CRP) of the 1985 Food Security Act and its extension as the Agricultural Resources Conservation Program in the Food, Agricultural, Conservation, and Trade Act of 1990 was designed to remove highly erodible land from crop production as a way to reduce soil erosion and nonpoint source pollution of waterways. We anticipated that the effect of this conversion would be to reduce the amounts of sediment and agricultural chemicals and nutrients entering the watershed's waterways. The economic impacts would depend on the relative amount of forage produced on the land, the use of the forage, the relative amount and value of the inputs used in producing the forage or the former row crop, and the relative value of the forage in comparison to the oilseeds or

grain formerly produced on the land.

Benefits and costs of changing land use patterns were projected based on ecological and socio-economic perspectives. We illustrate a replicable framework to integrate socio-economic and ecological parameters, and model impacts associated with land use changes in an economically sparse rural watershed. Our approach applied geographical information systems (GIS) to simulate and evaluate ecological changes resulting from land use changes, and economic modeling using a hybridized regional input/output model (IMPLAN) and the Small Area Assessment Model (SAAM) maintained by the Army Corps of Engineers.

The three scenarios were evaluated. Land use scenarios were compared as to their relative ecological benefits, and their impact on local and regional economies. Criteria of biodiversity, connectivity, and sedimentation were used to project ecological impacts. The impacts of land use changes on the economy were projected based on total industrial output, total personal income, and employment (Table ES-1).

Results indicate that establishment of the core area without development of a recreational component will have a positive effect on the development of habitat for wildlife and restoration of ecological functions. However, land use changes in the core area will have a negative effect on the economy due to the loss of agricultural production. After the first five years the projected shift of land out of agricultural production into the joint-venture restoration activities in the core area should

Table ES-1. Projection of Overall Economic and Ecological Effects Associated with Alternative Land Use Scenarios and Other Development Activities Within the Cache River Bioreserve in Southern Illinois.

	Economic Impacts			Ecological Impacts		
Industrial Scenario/Activity	Output ($MM)	Personal Income ($MM)	Employment	Sediment	Habitat[a]	Landscape[b]
Core Area Restoration	-2.088	-0.809	-22	+Low	+High	+Moderate
Filter Strips						
Big Creek (608 Ha)	-0.117	-0.006	-1.0	+Moderate	+Low	+Low
Cypress Creek (311 Ha)	-0.060	-0.003	-0.8	+Moderate	+Low	+Low
Watershed (12,145 Ha)	-2.340	-0.120	-30.0	+Moderate	+Moderate	+High
Erodible Cropland	Low	Low	Low	+Low	+Low	None
Visitor Center[c]	1.951	0.830	+26	None	None	None
Recreation Development[d]	1.449	0.401	+22	None	-Low?	None

---

[a] Anticipated change in availability of natural habitats (forest and wetlands) for fish and wildlife.

[b] Anticipated impact on connectivity and fragmentation of forest and wetland habitats across the watershed.

[c] Economic activity associated only with operation and maintenance over the first 5 years after construction.

[d] Includes recreation activities associated with the core area and private hunting clubs located in the buffer area.

cause a reduction in value of total economic output of $2.088 million, a reduction in personal income of $809 thousand, and a loss of 22 jobs. In contrast, the operation and maintenance of a visitor center and the other activities of the joint-venture partners in the core area should result in an increase of $1.951 million in total industrial output, a $830 thousand increase in personal income, and a gain of 26 jobs. Similarly, the projected recreational activities and the visitors to the area should result in an increase of total industrial output of $795 thousand, an increase in personal income of $304 thousand, and a net gain of 16 jobs. Taken together, the economic effects at the fifth year are projected to result in slight net increases in total industrial output of $658 thousand, in personal income of $324 thousand, and a net gain of 20 jobs. As local entrepreneurial and business activities expand over the fifteen years we project an increase in total industrial output of $3.003 million, and increase of $1.201 million in personal income, and a net increase of 96 jobs. Additionally, the establishment of core area activities will result in the expansion of private hunt clubs in the buffer area which will further positively affect the economy.

Establishment of filter strips is projected to produce modest ecological benefits and, depending on the amount and location of the strips, will have minimal economic impacts. Projected ecological effects include reduced levels of sediments and other nonpoint source pollutants, increased wildlife habitat,

and enhanced landscape connectivity. However, establishment of filter strips along waterways in the Cache River basin will have a negative effect on the local economy. For each 405 ha of land shifted from row crops to filter strips with forage, there would be a small reduction in total industrial output of $78 thousand, a small reduction in personal income of $4 thousand, and the loss of 1 job. Since there have not been any new federal appropriations for the Conservation Reserve Program (CRP) and its filter strip component, the potential for off-setting annual rental payments from the USDA was not considered in our analysis. If there were new appropriations for the CRP, the negative economic effects of establishing filter strips would be considerably reduced.

In the near term, the conversion of highly erodible land from row crop production to forage production appears to have minimal ecological and economic impacts. However, over a longer time horizon, the conversion could contribute to a reduction in erosion and eventually sedimentation in the watershed.

Finally, given the sparse nature of the five-county, rural economy and its lack of interconnectedness among economic sectors the economic benefits of the shift to a more recreationally based economy will be lost to the region without focused planning and investment. The additional economic activity derived from recreation will be captured by the counties surrounding the watershed (i.e., Jackson and Williamson counties, Il; McCracken and Ballard counties, Ky.; Mississippi and Cape Girardeau

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

counties, Mo.).

Using our approach, economic and ecological constraints can be imposed and evaluated in an iterative process that will lead to the formulation of a watershed management plans and land use scenarios to accomplish socio-economic and ecological objectives.

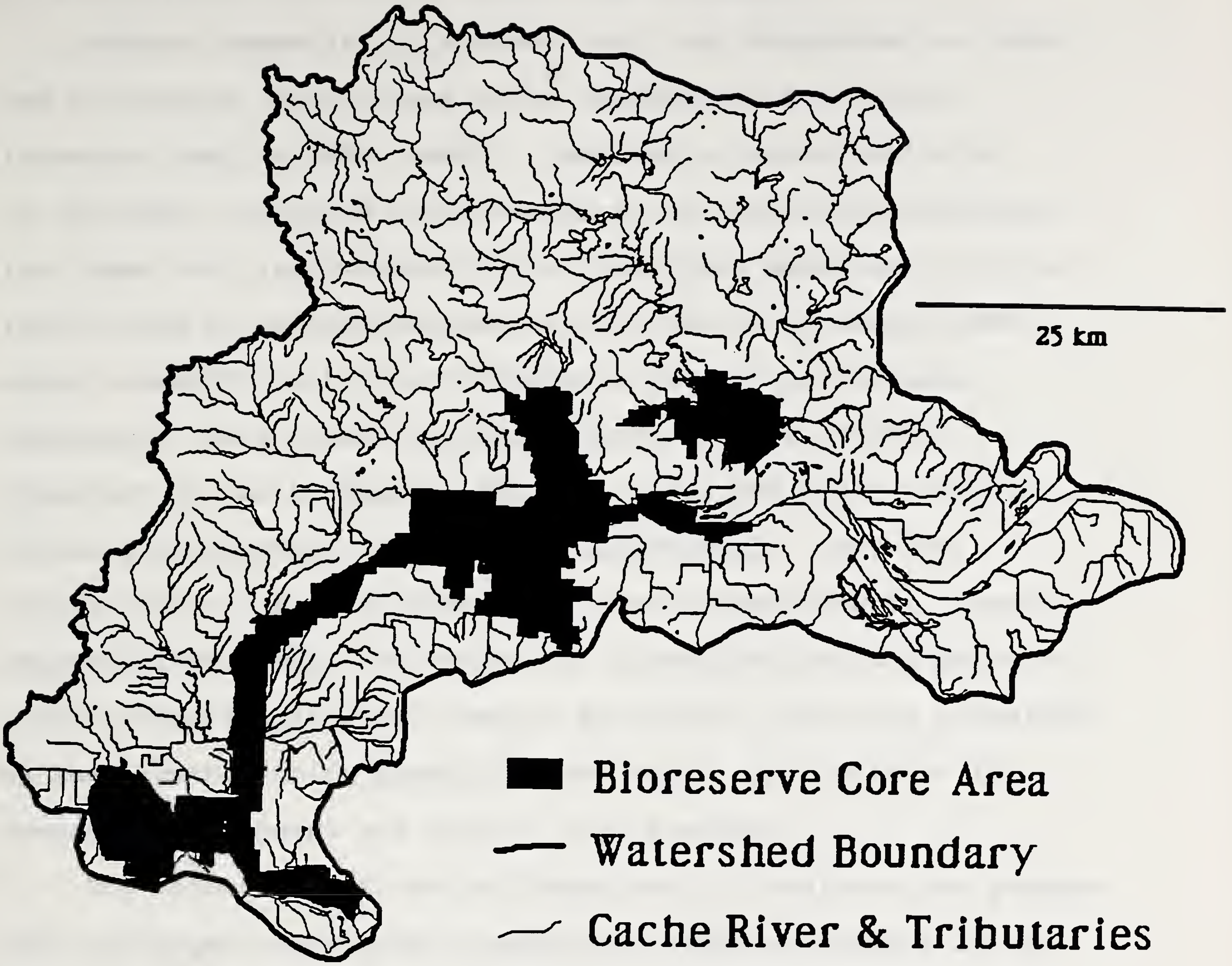
INTRODUCTION

Efforts to protect the environment and conserve natural resources and biological diversity increasingly require the integration of economic and ecological considerations in land use planning and policy formulation. Our goal was to develop an interdisciplinary approach to integrate ecological and economic concerns in watershed planning. A team of agricultural economists, wildlife ecologists, geographers, and foresters was assembled to collaborate in ecological and economic evaluation of land use scenarios designed to preserve, restore, and maintain natural ecological communities in a rural watershed in southern Illinois. Our challenge was to provide a planning framework for sustainable development of the local and regional economies that is compatible with protection and restoration of ecological function and biodiversity.

The Nature Conservancy has been collaborating with the U.S. Fish and Wildlife Service, the Illinois Department of Conservation, and Ducks Unlimited, Inc. in an interagency joint-venture project to preserve and restore wetlands and other natural communities along a riparian corridor of the Cache River in southern Illinois (Figure 1). The primary focus of land acquisition, preservation, and ecological restoration efforts of the joint-venture agencies are forested wetlands and cypress-tupelo swamp communities that uniquely characterize the Cache River watershed. These unique wetland ecosystems are threatened

Figure 1.

The Cache River watershed of southern Illinois showing locations of the bioreserve core area, the Cache River, and tributary streams.


25 km
Bioreserve Core Area
Watershed Boundary
Cache River & Tributaries

primarily by erosion, sedimentation, drainage, and clearing due to agricultural activities within the watershed.

Natural communities, whether small and fragmented or large and contiguous, are at some scale components of a larger landscape that is often heavily impacted by human activity. An important objective for research is to identify alternative land uses that are compatible with long-term sustainability and functioning of natural ecosystems, but that also support the human community that is an integral component of the same landscape. This issue has already received considerable attention in the context of national parks and their roles in economic development (see Machlis and Tichnell, 1987) and preservation of natural ecosystems (see Hiscock 1986). However, economic development and ecological sustainability has received little attention in rural regions of the U.S. that are perceived as less aesthetically appealing, and where opportunities for economic development are usually more limited.

The objectives of our work were to; (1) evaluate and project the ecological and economic impacts of land use changes in the Cache River watershed, (2) develop a replicable framework for integration of economic and ecological parameters in land use planning, and (3) acquire and compile economic and ecological data to support future land use planning and ecological/economic modeling activities for the Cache River watershed.

Three land use scenarios were selected as a starting point for integrating economic and ecological concerns in watershed

planning. Scenario 1 involved preservation and restoration of wetlands and other natural communities within a 23,687 ha ecological preserve located within the watershed. Scenario 2 was the conversion of row cropland to permanent vegetation cover within riparian zones of streams within a 171,702 ha buffer area surrounding the planned ecological preserve. Scenario 3 included conversion of highly erodible cropland to forage production for cattle within the buffer area. These 3 scenarios were selected based on initial perceptions of their potential to address ecological problems in the Cache River watershed, the realistic opportunities that they might present for economic development, and the existing public policies that facilitate the implementation of the proposed land use changes. We used our evaluations of these scenarios to develop and illustrate a replicable framework to guide land use planning in a predominantly rural watershed.

APPROACH

The biosphere reserve concept was used to specify the geographic regions for ecological and economic analyses. A biosphere reserve consists of a core area (ecological preserve), and one or more buffer areas, that are surrounded by an impact region located outside the biosphere reserve (UNESCO n.d., Batisse 1982, Jenkins n.d., Noss 1992). We use the term bioreserve in a manner analogous to the biosphere reserve. Following Batisse (1982) a bioreserve has a protected core area

that is surrounded by one or more buffer zones. The core area is intended to protect ecological resources that are critical to maintenance of desired ecological functions and the preservation of biodiversity within unique and/or highly valued natural communities. Surrounding the core area is a buffer zone that we defined as the portion of the Cache River watershed not included within the core area. The buffer area acts as a transition zone between the core and the geographical region outside of the bioreserve (Batisse 1982). Human activities in the buffer area have a direct impact on the ecological integrity of the core area. Traditional land uses, manipulative research, and exploitation of natural resources are generally permitted within the buffer area, but these must be compatible with desired ecological functions and long-term sustainability of the bioreserve ecosystem.

We defined 5 spatially distinct, but connected economic regions. These were the bioreserve core area, a local impact region, (the 5 southern Illinois counties that comprise the Cache River watershed), outlying rural economies (rural portions of counties in Illinois, Kentucky, and Missouri that surround the local impact region), urban portions of the surrounding area, (Carbondale IL, Marion IL Paducah KY, and Cape Girardeau MO), and the rest of the world. The regional economy was defined as the 5 county area that encompassed the watershed (Alexander, Jackson, Johnson, Pulaski, and Union counties). Except for special tabulations of 1987 Census of Agriculture data, all economic data

pertained to this 5 county area.

Using the bioreserve concept, we developed models and analyzed data to assess the ecological and economic impacts of the 3 land use scenarios. Scenario 1 (core area restorations) involved estimating the impact of shifting land use in the core area from agricultural production to protection and restoration of wetlands and other habitats with attendant production of wildlife, recreational, and ecological uses. This change in land use incorporated restoration of natural communities and development of wildlife habitats within the core area. This work was a reestimation based on earlier work by Beck et al. (1990). In contrast to Beck et al. (1990) this study made greater use of locally derived data to characterize the regional economic model (IMPLAN). Additionally, more accurate data on the size and scope of activities of joint venture agencies were available for the present study. Use of locally derived data allowed us to develop a limited hybridized form of a regional input/output model. Specifically, we initialized the existing regional economy to represent each of the three land use scenarios. We then examined the effects that each land use scenario was projected to have on the regional economy.

We examined changes in the recreational portion of the economy over a 15 year period. We estimated the economic impacts of land use changes at 5, 10, and 15 years after the start of the joint venture project. This allowed us to account for the gradual acquisition of land for the core area and to predict or

account for a gradual increase in entrepreneurial activity on the part of local business people. Greater entrepreneurial and business activity would result in a larger proportion of the demand for goods and services by visitors to the area being supplied locally. This, in turn, would have positive benefits for the entire regional economy. Expanded entrepreneurial activity could result from a number of sources. For example landowners who have sold land to the joint venture partners in the core area could invest the proceeds of the sale in new local businesses serving recreational visitors to the area. Additionally, there will be other economic opportunities identified and developed resulting in additional sources of local income and employment within the region. Furthermore, business education programs carried out in the region by the local junior college, the regional development commission, or Illinois Department of Commerce and Community Affairs could have the impact of stimulating greater entrepreneurial activity.

Scenario 2 was the substitution of filter strips for row cropland along major tributaries of the Cache River. Under existing USDA policy (i.e., the Conservation Reserve Program), filter strips are permanent woody or herbaceous vegetation zones established along waterways that range in width from 20 to 30 meters (Soil and Water Conservation Society, n.d.). These strips act as filters reducing levels of sediment, crop nutrients, pesticides, and other chemicals that are introduced from higher cropland into the waterways (Cooper et al. 1987, Forman and

Godron 1986, Karr and Schlosser 1978, Kovacic et al. 1993, Mass et al. 1985, Peterjohn and Correll 1984, and Schlosser and Karr 1981). Additionally, filter strips could enhance connectivity among nonagricultural land in the watershed. This increase in connectivity potentially has beneficial effects on flora and fauna of the watershed. We used this scenario to assess the ecological and economic impacts of improving riparian vegetation communities in the watershed. However, filter strips substitute grasses or trees for row crops with greater short-term economic value. Consequently, establishing filter strips may represent an economic cost to the regional economy. Under existing federal policy (i.e., the Conservation Reserve Program) farmers who place land in filter strips receive an annual rental payment from the federal government for a ten year period.

Scenario 3 was the conversion of highly erodible upland from row crop to forage production. We anticipated that a portion of the increase in forage production would be used to support cattle production with the balance being sold as a cash crop. The Conservation Reserve Program (CRP) of the 1985 Food Security Act and its extension as the Agricultural Resources Conservation Program in the Food, Agricultural, Conservation, and Trade Act of 1990 was designed to remove highly erodible land from crop production was a way to reduce soil erosion and nonpoint source pollution of waterways. While landowners enrolled in CRP are limited in the uses to which they can put the land, we evaluated an alternative in which farmers could continue to harvest hay or

graze the forage established on highly erodible land. We anticipated that the effect of this conversion would be to reduce the amount of sediment and agricultural chemicals attached to the sediment entering the watershed's waterways. Through the first eleven signup periods for the CRP, the average per acre reductions in erosion in the Cornbelt were 18 tons per acre per year (USDA-ERS 1992, p. 24). For Illinois, the average reduction in erosion in tons per acre per year for land placed in the CRP was 20 (Osborn et al. 1992). The economic impacts would depend on the relative amount of forage produced on the land, the use of the forage, the relative amount and value of the inputs used in producing the forage or the former row crop, and the relative value of the forage in comparison to the oilseeds or grain formally produced on the land. Furthermore, such conversions would be consistent with the Conservation Compliance provisions of the 1985 and 1990 Farm Bills. Through Conservation Compliance, farmers remain eligible for USDA program benefits if they use highly erodible land in ways that minimize soil loss.

Benefits and costs of changing land use patterns were projected based on ecological and socio-economic perspectives. We illustrate a replicable framework to integrate socio-economic and ecological parameters, and model impacts associated with land use changes in an economically sparse rural watershed. Our approach applied geographical information systems (GIS) to simulate and evaluate ecological changes resulting from land use changes, and economic modeling using a hybridized regional

input/output model (IMPLAN) (University of Minnesota 1989) and the Small Area Assessment Model (SAAM) maintained by the Army Corps of Engineers. The three scenarios were evaluated. Land use scenarios were compared as to their relative ecological benefits, and their impact on local and regional economies. Using our approach, economic and ecological constraints can be imposed and evaluated in an iterative process that will lead to formulation of a watershed management plan to accomplish socio-economic and ecological objectives (Figure 2).

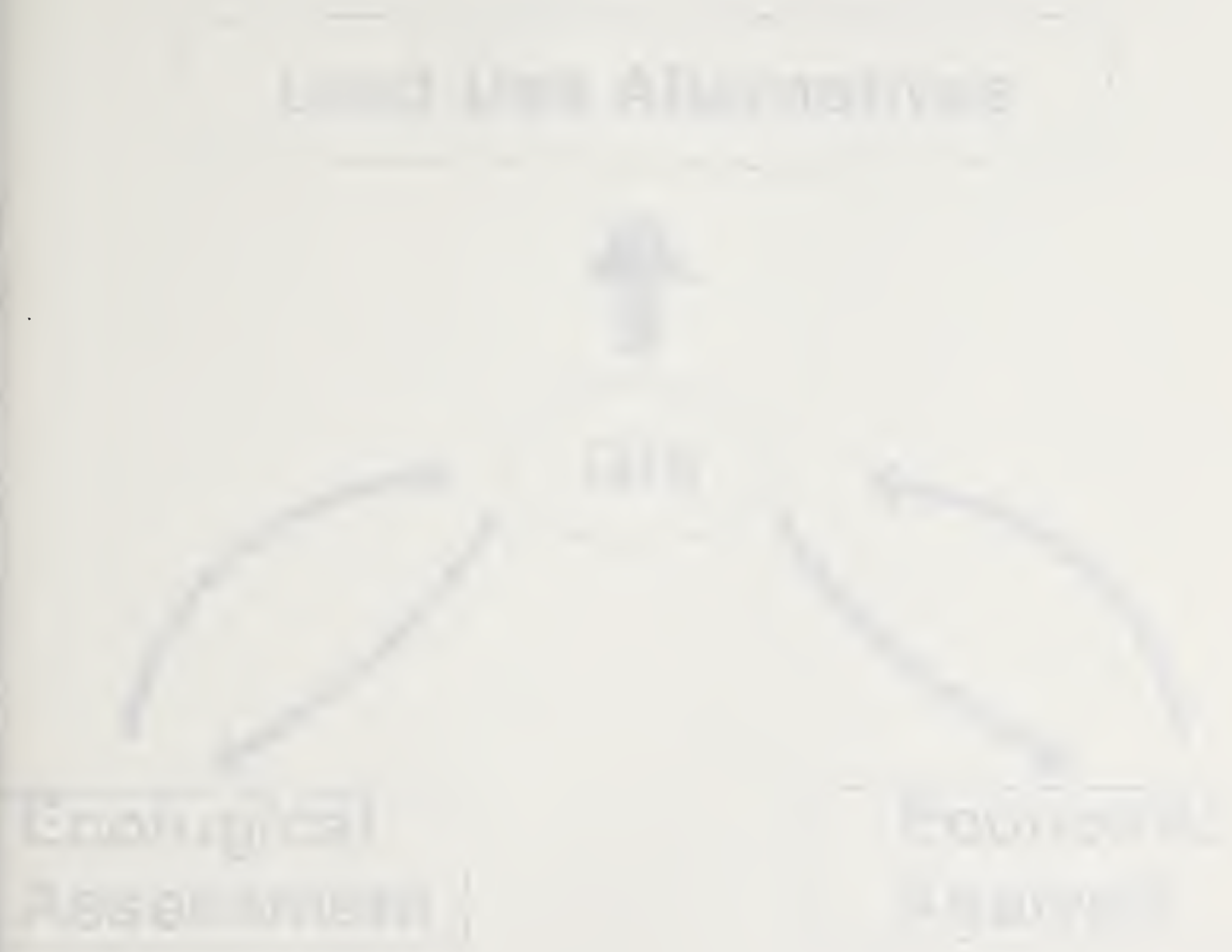
ECOLOGICAL DESCRIPTION OF THE AREA

The Cache River watershed encompasses 1,944 km^2 within Alexander, Johnson, Massac, Pulaski, and Union counties in southern Illinois (Figure 3). Located near the confluence of the Mississippi and Ohio Rivers, the watershed lies at the juncture of four physiographic provinces; Central Lowlands, Interior Low Plateau, Coastal Plain, and Ozark Plateau (Demissie et al. 1990). The center of the bioreserve core area (ca. Perks, IL) is located 34 km north of Cairo, IL, 46 km northwest of Paducah, KY, and 47 km south of Carbondale, IL. Elevations in the watershed range from 271 m in the northernmost portion, to 85 m at the Mississippi River in the southwest.

Soils within the watershed include upland loessal and bottomland alluvial soils (U. S. Army Corps of Engineers 1992). Most soil associations in the watershed contain < 25 percent prime farmland. Upland soils on steep slopes are generally well

Figure 2.

General approach used to link economic and ecological assessments of land use alternatives for the Cache River Bioreserve in southern Illinois. Geographic information systems (GIS) provided a link between ecological assessment and economic modeling activities. This approach can be used to iteratively assess ecological and economic impacts of land use scenarios.



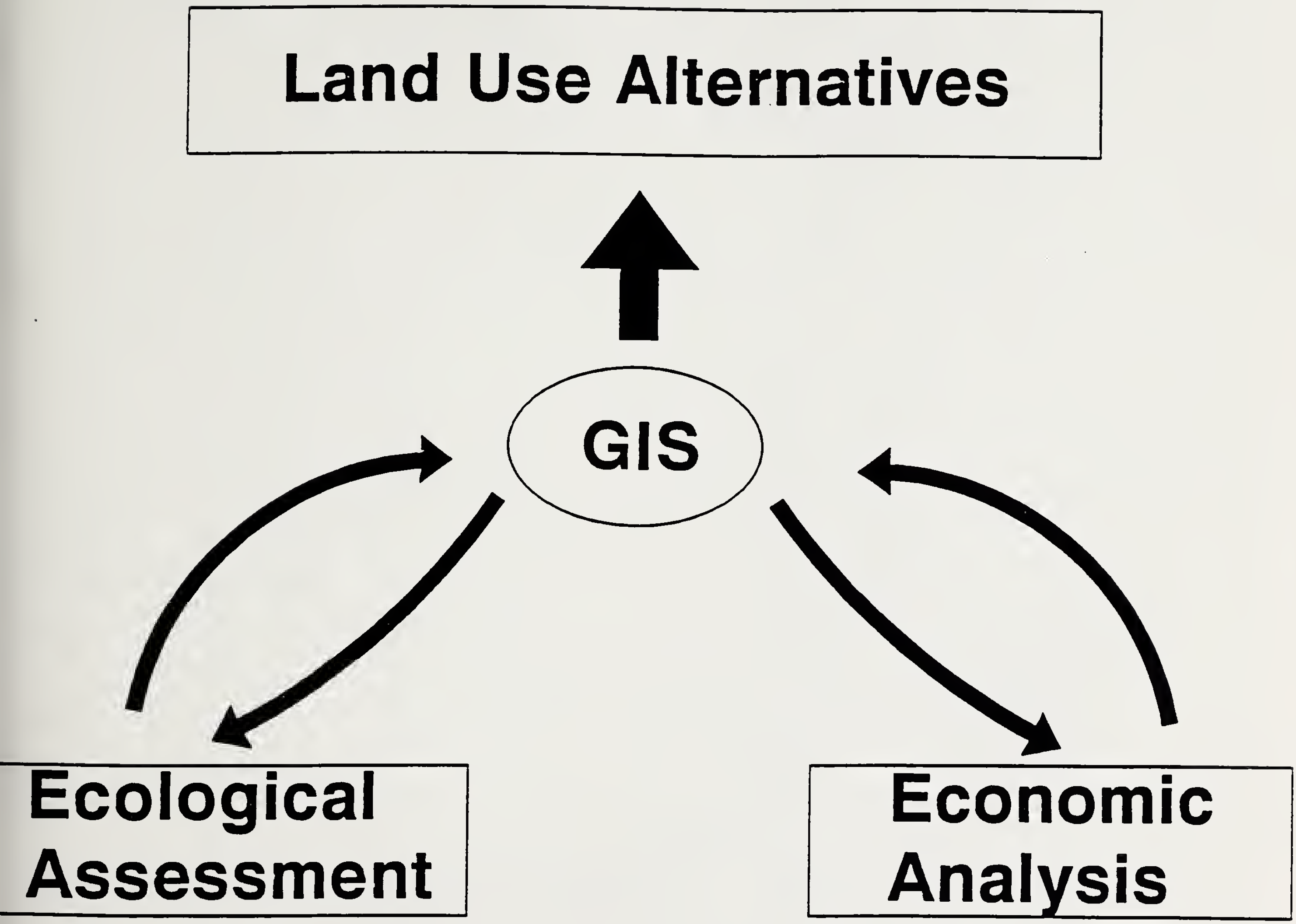
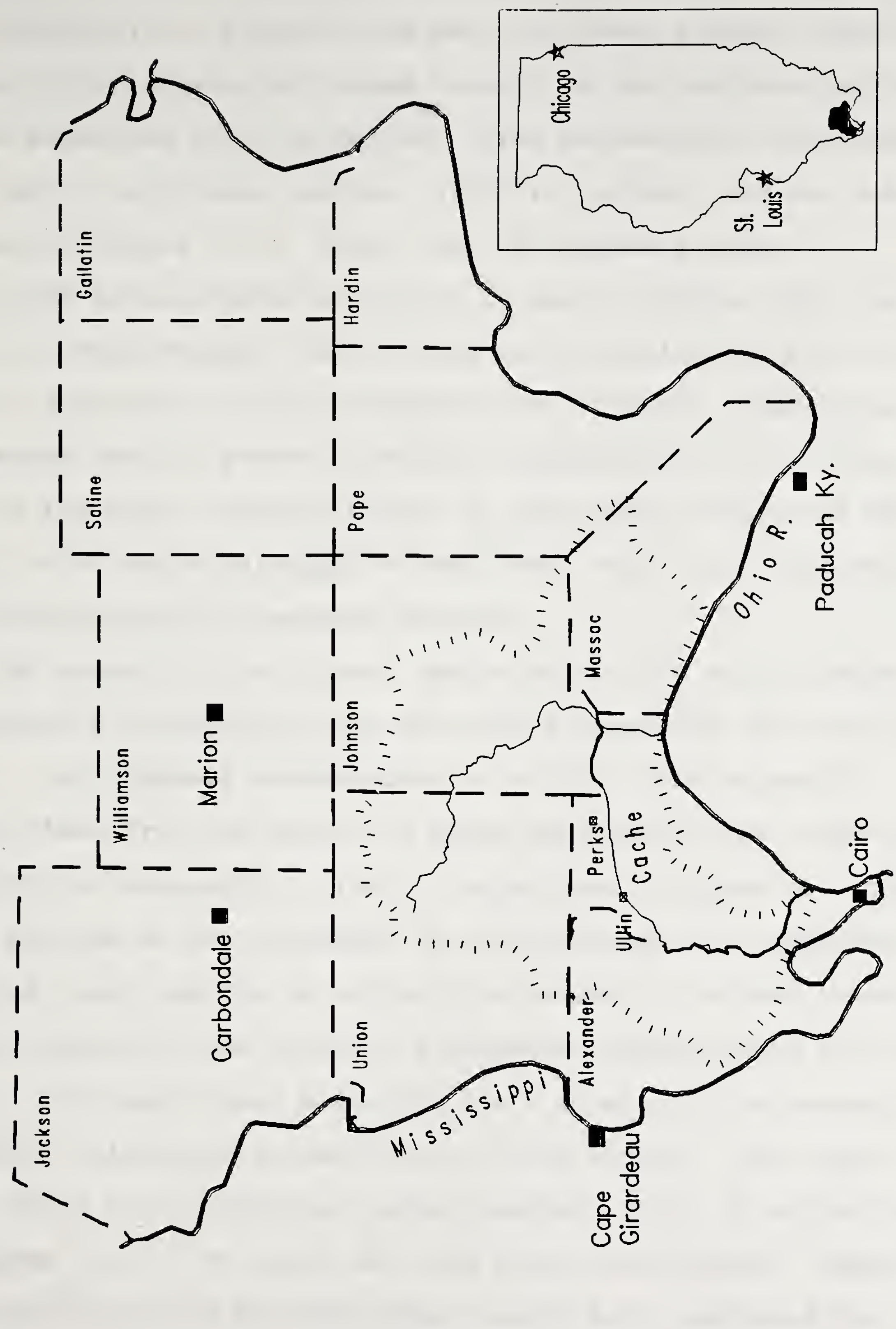

Land Use Alternatives
GIS
Ecological Assessment
Economic Analysis

Figure 3.

Location of the Cache River watershed within the five county region of southern Illinois.



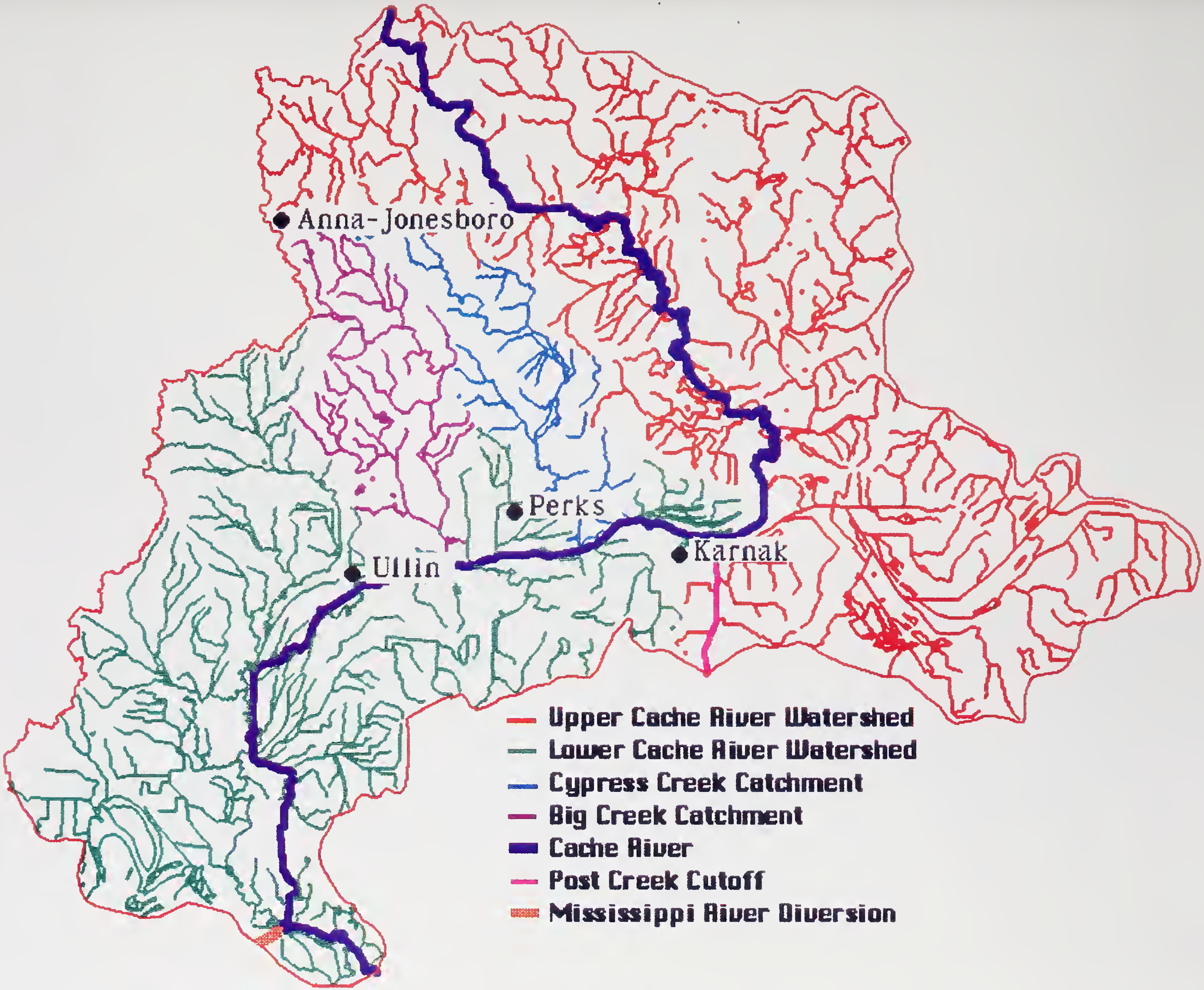
Chicago
St. Louis
Gallatin
Hardin
Saline
Pope
Williamson
Marion
Johnson
Massac
Ohio R.
Paducah Ky.
Jackson
Carbondale
Union
Alexander
Perks
Ullin
Cache
Cairo
Mississippi
Cape Girardeau

drained but have low organic matter content in the surface layer, are susceptible to erosion, and have low water storage capacity (Davie 1991). Soils on rugged terrain in the northern portion of the watershed are < 25 percent prime farmland but can support hay, native hardwoods, pasture, wildlife habitat, and row crops on gentler slopes (U. S. Army Corps of Engineers 1992). Bottomland soils consist of clayey to sandy alluvium that are poorly to well-drained. Bottomland soil associations are 25 - 75 percent suitable for crop production but frequent flooding and persistent wetness prevent consistent production of row crops. Most of the prime farmland occurs on the upper terraces of the Cache, Ohio, and Mississippi Rivers where soils were developed from medium and fine-textured outwash.

The historic Cache River, approximately 176 km in length, discharged surface water from the entire watershed into the Ohio River. Two channels constructed in 1912 and 1950 currently divert flows from the upper and lower portions of the Cache into the Ohio and Mississippi Rivers, respectively (Figure 4). The upper portion of the watershed is now hydrologically separated from the lower portion by a diversion channel, the Post Creek Cutoff, through which water is discharged directly into the Ohio River. The upper Cache River follows a sinuous 91 km channel, through a relatively narrow valley (<1 km width). The upper Cache River has a relatively steep gradient (19 - 28 cm/km) that increases to 47 - 57 cm/km near the Post Creek Cutoff. Channel modifications above the Post Creek Cutoff have shortened the

Figure 4.

The Cache River watershed of southern Illinois highlighting the locations of the Big and Cypress Creeks, and modifications to the surface water drainage patterns caused by the Post Creek Cutoff and the Mississippi River Diversion.


Anna-Jonesboro
Perks
Karnak
Ullin
Upper Cache River Watershed
Lower Cache River Watershed
Cypress Creek Catchment
Big Creek Catchment
Cache River
Post Creek Cutoff
Mississippi River Diversion

length of the upper Cache River.

Construction of the Post Creek cutoff in 1912, levee construction to form the Forman Floodway in 1915, and channel modifications during the 1930s changed the hydraulics of the upper watershed, causing entrenchment of the upper river channel (Demissie et al. 1990). Channel entrenchment is expected to continue migrating upstream until the river reaches an equilibrium for its water to sediment ratio (U. S. Army Corps of Engineers 1992).

The Lower Cache River below the Post Creek cutoff flows through an ancient channel of Ohio River (Esling et al. 1989). Consequently, much of the lower river channel follows a mild gradient (4 - 6 cm/km) through a broad (6.4 km) poorly drained floodplain. The stream gradient steepens to about 19 cm/km in the lower reaches of the Cache River, near its confluence with the Mississippi River. Originally about 80 km in length, the lower Cache River was shortened to 56 km by a series of stream modifications that were constructed during the 1930s to speed discharge of flood waters (U. S. Fish and Wildlife Service 1990). Two major tributary streams of the lower Cache (Cypress and Big Creeks) also have been extensively channelized and straightened.

A diversion channel located 11 km upstream from the mouth of the Cache River now discharges flow from the lower Cache River directly into the Mississippi, rather than the Ohio River as occurred before the diversion. Only the last 11 km of the Cache River discharges flow through the original outlet to the Ohio

River. Consequently, the lower reaches of the Cache River are subject to backwater flooding from the Mississippi River as far upstream as Ullin, IL.

Alteration of surface water drainage patterns, and past and current land use practices have rearranged soil and sediments within the watershed. About 67 percent of the total gross sediment load is retained within uplands, the balance being discharged into the Mississippi River. Seventy percent of sediments retained in the watershed is deposited in wetlands and stream channels of the lower watershed; the balance retained in the lower watershed is deposited in wetlands and stream channels. The balance (30 percent) is trapped within fields and other upland areas with level topography (U. S. Fish and Wildlife Service 1990).

Sheet and rill erosion account for 74 percent of the annual gross sediment load in the lower watershed (U. S. Fish and Wildlife Service 1990). Gully and streambank erosion are the sources of 23 percent of annual gross sediment load in the lower watershed. Over 85 percent of sheet and rill erosion is estimated to originate from cropland. Much of the sediment eroded from cropland over the past several decades, when agriculture land use was more intensive and before soil and water conservation practices were widely implemented, may be stored in the beds and banks of tributary streams (Davie 1991).

Sediment deposition has most severely impacted the first 24 - 32 km of the Lower Cache River. This area, known as

Buttonland Swamp, is characterized by a broad, shallow, and poorly defined river channel with low gradient. The buttonland swamp is a sediment trap, retaining 69 - 84 percent of sediments contributed by 7 subwatersheds that discharge into the area (Demissie 1989).

Big and Cypress Creeks discharge most of the sediments deposited in Buttonland Swamp. Sediment discharge from Big Creek exceeds that of the entire lower Cache River watershed because sediments are retained in Buttonland Swamp and adjoining wetlands (Demissie 1989). Big and Cypress Creek catchments are adjacent to each other and have similar soil characteristics, yet Big Creek discharges several times more sediment than Cypress Creek. Demissie (1989) proposed that sediment yield from Big Creek exceeded Cypress Creek because of differences in stream channel and floodplain characteristics. Floodplains within the Cypress Creek catchment have greater forest cover than Big Creek where floodplains are essentially devoid of tree cover. Forested riparian zones are effective sediment traps, thereby reducing downstream sediment loads.

Before construction of the Post Creek cutoff, water flow from the upper watershed facilitated transport of sediments discharged into the Lower Cache River. Channel modifications of Big and Cypress Creeks and the diversion of water through the Post Creek cutoff cause frequent reversals of flow in this segment of the lower Cache River.

The primary ecological problem in the upper watershed is

streambed and bank erosion caused by channel entrenchment after construction of the Post Creek cutoff and Forman Floodway. Continued entrenchment and bank erosion threatens to drain Heron Pond and Little Black Slough, two of the largest remaining cypress-tupelo swamps in the region. Gully and bank erosion contributes 21 percent of the sediment load in the upper watershed, but sheet and rill erosion from cropland is still estimated to be the largest source of sediment load in the upper watershed.

Erosion and sedimentation are the princip~~le~~al problems that threaten the ecological integrity of riparian wetlands and swamps that remain within the Cache River watershed (U. S. Fish and Wildlife Service 1990). Deposition of sediments eroded from surrounding uplands and the beds and banks of tributary streams poses the greatest imminent threat to natural wetland and riparian communities along the lower Cache River. Accumulation of sediments has altered natural hydrologic regimes of riparian wetlands and swamps, and threatens the existence of wetland communities. Additionally, sediment accumulation reduces streamflow and increases the potential for flooding (U. S. Fish and Wildlife Service 1990).

Unique and diverse plant and animal communities that remain in the Cache River watershed has led to designation of 58 sites as Natural Areas by the Illinois Department of Conservation; 2 sites have been designated as National Natural Landmarks by the U. S. Department of Interior (U. S. Soil Conservation Service

1987). At least 100 species of plants and animals on the Illinois threatened and endangered species list are known to occur within the watershed. In addition, the Cache River basin supports 10 globally rare or endangered species and ecological communities.

Current threats to the ecological integrity of the Cache River ecosystem include: (1) loss and further fragmentation of natural habitats for plants, fish, and wildlife; (2) dramatic alterations to the natural hydrologic regimes of stream systems and wetlands; (3) excessive erosion and sediment deposition in wetlands; (4) degradation of surface and ground water quality; and (5) land use and economic development activities that are incompatible with long-term maintenance of natural ecological systems.

Prior to settlement in the early 1800s, 80 percent of the Cache River watershed is thought to have been densely forested (Hutchinson 1984). Forest openings probably occurred largely as semi-treeless barrens in the Cretaceous Hills Section (Schwegman 1973) in the southern portion of the watershed. Other openings also occurred where wetlands were too deep to support growth of woody vegetation. Before this century, the watershed may have contained over 100,000 ha of wetlands (Roelle and Hamilton 1992).

Extensive forest clearing for harvest of wood products and clearing for agriculture occurred around 1900. In addition, an estimated 90,000 ha of wetland have been drained in the Cache River watershed since construction of the Post Creek Cutoff in

1912 (U. S. Fish and Wildlife Service 1990). By the 1970's the watershed consisted of about 70 percent agricultural land, 22 percent forest, 6 percent wetland, and 2 percent urban (U. S. Army Corps of Engineers 1992). Current land use/cover types within the watershed include marsh and swamp wetlands, bottomland and upland deciduous forest, prairie, old-field, pasture/hay lands, and row cropland.

Despite dramatic changes that have occurred in the natural environment, biodiversity within the Cache River watershed remains high. Of six regions of the United States where four physiographic provinces overlap, species diversity is thought to be highest in the Cache River region (U. S. Fish and Wildlife Service 1990). Floristic surveys have documented presence of 138 species of woody plants, 251 species of herbaceous plants and 11 species of ferns. Eighty plant species are listed as threatened or endangered in the state of Illinois. Many plant species occurring within the watershed are at or near the northern terminus of their geographic ranges, most notably bald cypress and water tupelo.

The predominant ecological features of the watershed are bottomland hardwood forests and cypress-tupelo swamps that occur within the floodplains of the upper and lower Cache River. Remnant swamps are dominated by old and second growth stands of cypress and water tupelo that include other flood-tolerant species such as pumpkin ash, water hickory, water locust, swamp red maple, buttonbush, and swamp privet. Several cypress and

other trees in the oldest known stands are thought to be several hundred to over 1,000 years old. Bottomland hardwood forests occur in seasonally flooded areas between permanently flooded swamps and the surrounding uplands. Bottomland forests consist of species such as cottonwoods, sweet gums, oaks, hickories, elms, ash, sycamores, and maples.

The Cache River region also provides habitat for diverse communities of fish and wildlife (U. S. Fish and Wildlife 1990). A total of 87 fish species representing 19 families has been found in the main channel and tributaries of the Cache River, including several state listed threatened and endangered species. Additionally, 25 species of snails and 17 species of mussels occur in the Cache River system.

At least 181 bird species are residents, breed within, or migrate through the watershed. Many are state or federally listed endangered species. Among the most notable species are Mississippi kite, Swainson's warbler, loggerhead shrike, bald eagle, and interior least tern. The Cache River also provides important migration, breeding, and winter habitat for recreationally important species such as mallards, wood ducks, Canada and snow geese, wild turkeys, northern bobwhites, mourning doves, and woodcock.

ECONOMIC DESCRIPTION OF THE AREA

The health of the human community and the Cache River ecosystem are closely linked to how natural and human resources

are used in this rural area. The new Cypress Creek National Wildlife Refuge (NWR) on the Cache River supports efforts to protect and restore unique ecological communities, particularly forested wetlands and cypress-tupelo swamps within the bioreserve core. A review of the political process that led to the creation of the refuge can be found in Schwegman (1991).

Agricultural and other activities within the surrounding buffer area have profound effects on the human services and ecological functions that natural communities within the core area provide. However, purchase of the entire watershed by joint venture agencies is neither financially feasible, nor desired by the local populace. Challenges of economic development and natural community restoration in the Cache River region include (1) identifying economic development opportunities in the watershed that will replace or enhance economic activity after establishment of the bioreserve, and (2) proposing alternative land use scenarios outside the core area that are ecologically compatible with preservation of natural communities throughout the watershed. The watershed is part of a diversified, although fragile, regional economy.

Although the biodiversity of plant and animal life is high in the region, sustained economic viability of the area is threatened by evidence of low per capita incomes, high unemployment rates, outmigration, and high population dependency ratios (Table 1). From 1980 to 1990 the area lost 2.6 percent of its population (Slater and Hall 1992), ending the decade with

Table 1. Population and Housing Data, Five County Region, 1990

County	Total Persons	Labor Force	Economically Active Population (EAP)[a]	Unemployment Rate	Per Capita Income 1989
Alexander	10,626	3,400	31.9	15.6	$10,694
Johnson	11,347	4,238	37.3	10.9	9,593
Massac	14,752	4,678	31.7	9.9	12,491
Pulaski	7,523	2,354	31.2	14.1	11,426
Union	17,619	8,309	47.2	11.5	13,476
State of Illinois	11,430,602	6,029,000	52.7	6.2	18,870

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[a] Economically Active Population (EAP) is equal to labor force divided by population (total persons) times 100.

Source: 1992 County and City Extra: Annual Metro, City and County Data Book.

61,867 persons. In only one of the counties, Johnson, was the proportion of this population in the ages of 25-34 higher than the average for the state. Four of the five counties had fewer than 15 percent of their population in the age category of 25-34 while the state average was 17.4 percent. Only 37.1 percent of the region's population was in the labor force while the state's proportion was 53 percent (Table 1). Unemployment rates were higher in every county than the state's 1990 average of 6.2 percent (Table 1). The ratio of per capita income in the area to the state ranged from 50.8 to 71.4, (Table 2).

However, living costs are also lower than the state average with the ratio of county median rent to state median rent ranging form 33.6 to 42.5 (Table 2). To put these ratios in perspective, one must realize that housing is both an investment and a consumption expense. Higher incomes in a region lead to more expensive housing stock in a region as well (Table 2). Another indication of the region's economy can be drawn from an examination of the proportion of personal earnings derived from different sources (Table 3). The percentage of earnings from wages and salaries which reflect the vitality and strength of an economy ranged from 37.5 percent to 44.1 percent, considerably lower than the state average of 65.0 percent. At the other end of the spectrum, transfer payments as a proportion of total personal income ranged from 24.2 percent to 32.5 percent, considerably above the state average of 13.1 percent (Table 3). These data reflect a population and an economy that can hardly be

Table 2. Economic Indicators, Five County Region, by Source, 1990

County	County PCI[a] / State PCI %	County EAP / State EAP[b] %	Owner-Occupied Housing Median Value, 1990 $	Median Housing Value[c] County / State %	Median Rental Value[d] County / State %
Alexander	56.6	60.5	23,900	29.5	33.6
Johnson	50.8	70.8	36,800	45.4	40.6
Massac	66.1	60.1	35,700	44.1	42.5
Pulaski	60.5	59.2	24,000	29.7	36.0
Union	71.4	89.6	36,700	45.3	45.5
State of Illinois			80,900		

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[a] County's per capita income (PCI) as a percentage of the state's (PCI)

[b] County's economically active population (EAP) as a percentage of the state's (EAP)

[c] County's median housing value as a percentage of the state's median housing value

[d] County's median housing rental value as a percentage of the state's median housing rental value

Source: 1992 County and City Extra: Annual Metro, City and County Data Book

Table 3. Personal Income, Five County Region by Source, 1989

County	Wages and Salaries %	Proprietor's Income %	Dividends, Interest, Rent %	Transfer Payments %
Alexander	42.2	14.6	13.8	32.5
Johnson	27.5	15.6	19.3	26.6
Massac	44.1	11.7	18.1	25.5
Pulaski	37.5	15.6	13.5	29.2
Union	40.3	13.6	17.7	24.2
State of Illinois	65.0	8.9	18.1	13.1

Source: 1992 County and City Extra: Annual Metro, City and County Data Book.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]		[illegible]
[illegible]	[illegible]	[illegible]		[illegible]
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[illegible]

described as vibrant and growing. Rather, these statistics portray an only too real picture of poverty and dependence on government, social security, and other transfer payments. This area is part of the designated Lower Mississippi Delta Development Commission.

> People who live here "by virtue of place are surrounded by thousands of square miles of some of the country's richest natural resources and physical assets and who have used their sense of place to develop a cultural and historical heritage that is rich and unique. And yet, these are the people who by statistics constitute the poorest region of the United States of America; where jobs are scarce..." (Lower Mississippi Delta Development Commission 1990, p.6).

Finally, agriculture accounts for about 2.6 percent of the net personal income in the region. (See Beck et al.(1990) for a detailed discussion of the structure of the economy.)

The structure of the region's agricultural economy in light of existing conservation policy as promulgated in the 1985 and 1990 farm bills can have a direct effect on the extent to which those policies can be used in the watershed to foster land uses that protect the endangered ecosystems. Tables 4 and 5 provide summary information on the agricultural sector in the five counties of the core and buffer areas. According to the 1987 Census of Agriculture, there were 1902 farms in the five county area. These farms encompassed a total of 197,976 ha. of land of

Table 4. Agriculture in Five County Region, 1987.

County	Number of Farms	Average Size of Farm Ha	Total Acreage (1,000 Ha)	Total Cropland (1,000 Ha)
Alexander	184	161	29.6	24.3
Johnson	476	85	40.5	27.5
Massac	414	102	42.1	34.8
Pulaski	244	136	33.2	27.9
Union	580	90	52.6	37.7
State of Illinois	88,786	130		

Source: 1987 Census of Agriculture

Table 5. Description of Agriculture, Five County Region, 1987.

County	Average Value of Land and Buildings Per Ha (Dollars)	Average Value of Products Sold Per Farm (Dollars)	% of Value of Products from Crops	% of Value of Products from Livestock	% of Farms With $10,000 or More in Sales	% of Farms With $100,000 or More in Sales
Alexander	1717	44,464	85.4	14.6	54.9	11.4
Johnson	1517	22,470	34.5	65.5	32.1	4.0
Massac	1675	36,539	48.5	51.5	52.4	11.8
Pulaski	1549	48,184	68.9	31.1	54.1	13.5
Union	1796	29,958	64.9	35.1	39.0	6.4
State of Illinois	3117	71,822	65.2	34.8	70.6	22.1

Source: 1987 Census of Agriculture

which 152,227 ha. were cropland. Table 5 demonstrates the size of the farms in the five county area relative to the state-level average data. Across the five counties, the average per hectare value of the land and buildings was $1,662 compared to $3,117 for the state. Similarly, the average value of the products sold per farm in the five county area was $36,323 compared to an average of $71,822 for the state. In other words, the average size of the farms in the five county area when measured by the value of products sold was just barely 50 percent of the state average.

In 1987 there were 894 farms located within the Cache River watershed (U.S. Census Bureau 1993)[1]. These farms had a total of $31 million of gross farm sales in 1987 with an average of $36,467 per farm. However, the size distribution of the farms based on sales was quite skewed. Median farm size in terms of sales was $8,700 while farms at the 75th quartile had sales of $24,244. Both of these figures are below the mean. A similar distribution exists for farms based on acreage. These farms encompassed 92,432 ha. with an average of 103 ha. per farm. The area has a large number of "small farm operations" with a very small number of large commercial farms accounting for most of the agricultural production in the area. This is characteristic of the emerging dualistic structure of American agriculture (Carr 1980) and has implications for changing the use of agricultural land in the watershed.

In 1987, of the 894 farms in the watershed, only 249 or 28 percent were participating in USDA governmental programs to the

extent of receiving cash payments. Since a number of the existing conservation programs designed to reduce nonpoint pollution and protect wetlands (e.g., conservation compliance and swampbuster) rely on the incentive of USDA program payments to encourage farmers to participate, the small number of participants limits the potential impact of these conservation programs. The small size of the farms was also reflected in the average value of $151,572 per farm in land and buildings for the farms in the watershed. The median value was $100,000. Forty-eight percent of the farm operators indicated that farming was their principal occupation. Forty-three percent of the operators worked 200 or more days off the farm (U.S. Census Bureau 1993).

In any fashion the data are arranged or by any indicator examined, the same conclusion is drawn. The economy of the 5 county region is an anemic, dependent one, and without an injection of investment capital resulting in expanded or diversified economic activity, the economic welfare of the residents will continue to erode.

METHODS

ECOLOGICAL ASSESSMENTS

We used geographic information (GIS) and digital image processing systems to analyze and simulate current and alternative land use scenarios for the Cache River basin. Data were processed, analyzed, and output using ARC/INFO (Environmental Systems Research Institute, Inc., Redlands, CA)

and the Map and Image Processing System (MIPS; MicroImages, Inc., Lincoln, NE).

Current land use/land cover of upland areas was determined from a Landsat 5 Thematic Mapper image dated 23 August 1991 (30 m pixel resolution). Wetland communities and riparian corridors were identified and mapped from National Wetlands Inventory (NWI) (1:24,000 scale) and Digital Line Graph (DLG) hydrography (1:100,000 scale) vector data purchased from the Illinois Natural History Survey and U. S. Geological Survey. The satellite image was georeferenced to the Universal Transverse Mercator system, providing a raster map base for overlay of NWI and DLG vector data layers.

Existing public land boundaries and planned acquisition areas of the Joint Venture Area and the Cypress Creek National Wildlife Refuge were manually digitized from maps provided by the U. S. Fish and Wildlife Service, The Nature Conservancy, and Illinois Department of Conservation. Boundaries of the Cache River watershed were digitized from 1:24,000 scale topographic maps. Vectorized DLG transportation features (road and rail networks) were used to fine-tune the co-registration of satellite imagery, NWI data, and digitized boundary layers to the DLG hydrography data.

Wetland and aquatic communities within the watershed (Table 6) were classified and mapped from NWI and DLG data. NWI and DLG hydrography vector data layers were merged so that intermittent streams from the DLG layer were included with wetlands and stream

Table 6. Current Land Use/Land Cover within the Cache River Watershed in Southern Illinois.

Land Use/Cover Class	Area (Ha)	Area (Percent)
Lake	805.7	4.1
River/Stream	152.6	0.1
Intermittent Stream	3.6	<0.1
Ditch	55.4	<0.1
Total Aquatic	1,017.3	0.5
Open Pond	2,386.5	1.2
Forested Wetland/Swamp	13,392.6	6.9
Shrub/Scrub Wetland	919.5	0.5
Marsh	108.5	0.1
Wet Meadow	1,318.1	0.7
Total Wetland	18,125.2	9.3
Upland Forest	48,755.6	25.1
Herbaceous	25,051.8	12.9
Orchard	319.7	0.2
Row Crop	94,373.5	48.6
Mine/Quarry	335.9	0.2
Roads	5,673.4	2.9
Urban	544.7	0.3
Total Upland	175,054.6	90.2
TOTAL	194,197.1	100.0

networks from the NWI layer. The merged wetland/stream network data layer was then rasterized and merged with the satellite image. NWI and DLG hydrography attribute codes were grouped into information classes that represented general wetland and aquatic community types present in the watershed. Grouping of NWI attribute codes followed the Illinois system of classifying wetland and deepwater habitats (Suloway et al. 1992).

Spectral classification of upland land use/land cover from satellite imagery was limited to areas within the watershed. Wetlands and aquatic areas previously identified from NWI and DLG data were excluded from classification by masking out portions of the imagery overlaid by the wetland/stream network data layer. Spectral bands 3 (visible red), 4 near infrared, and 5 (mid-infrared) were used to classify the majority of upland habitat classes. The MIPS module FEATURE MAP was used to group spectral reflectance classes into land cover information classes. Grouping was based on visual interpretation of spectral values from pseudocolor digital images. Interpretation and grouping of spectral classes into land cover types was aided by inspection of 1988 National Aerial Photography Program (NAPP) color infrared (CIR) photographs. These photographs and other sources were used to guide the classification as it progressed, and to facilitate identification of orchards, quarries and urban areas.

Satellite imagery for a small region in the southeast corner of the watershed was not available. Upland land cover mapping and classification for this area was interpreted and digitized

from National Aerial Photography Program color infrared photographs (1:40,000 scale).

Stream network line coverages from the DLG hydrography vector data layer were overlaid on the final classified image. Vector buffer polygons were constructed around DLG hydrography line elements to simulate placement of filter strips around streams outside the core area. Ninety meter wide buffers were placed around permanent streams; 60 m buffers were placed around intermittent streams. These buffer widths included the area on both sides of streambanks, areas occupied by the buffered streams themselves, and were not terrain corrected. Consequently, the buffer areas approximated (within the limits of resolution of the land use classification) areas that would be eligible for conversion to filter strips under CRP.

Current upland and wetland habitat composition within the buffered areas was summarized using database output from MIPS. Total areas and percent composition of upland, wetland, and aquatic habitats were also summarized for the entire watershed, within existing public land boundaries, and within planned acquisition boundaries for the Cypress Creek NWR and Joint Venture Area. Data on percent composition and total areas of lands currently under agricultural uses within the core area, and within and outside of buffer strips outside the core area were used to initialize IMPLAN characteristics before modeling the economic impacts of removing these areas from row crop production.

Relative ecological benefits anticipated from implementing the three land use scenarios were evaluated and compared on a qualitative basis. Our evaluation focused on projecting changes in three general areas; (1) reduction of erosion and sedimentation and improvement of water quality in wetlands and stream networks in the lower portion of the watershed, (2) changes in availability of habitat for fish and wildlife, and (3) fragmentation of forests, swamp, and other wetlands communities that provide habitat for native flora and fauna. We assessed potential impacts of land-use scenarios on sedimentation and water quality from results of previous studies and monitoring conducted within the watershed, and from studies investigating effectiveness of filter strips in controlling non-point source pollution. Potential changes in habitat availability were estimated using output from GIS simulations of each scenario.

Effects on habitat fragmentation were simulated using output from GIS. The original land use/land cover classification was modified to our facilitate analyses. The classified image was resampled to a pixel resolution of 1 ha. Land cover classes were grouped into forest/wetland habitat and non-habitat categories. Upland and bottomland forests, swamps, and other wetlands were considered habitat; quarry, urban, orchard, cropland, and herbaceous land cover types were considered non-habitat.

Spatial distributions of habitat and non-habitats were analyzed using the theory and techniques of landscape ecology (Forman and Godron 1981, Turner and Gardner 1991). The

fundamental concept underlying this approach is that current and future patterns of habitat distribution in the Cache River watershed affect the abundance and diversity of native plants, fish, and wildlife within the region. The landscape was viewed as a network of habitats with varying degrees of connectivity between habitat units (Hill 1985, Sharpe et al. 1987, Whitney and Somerlot 1985). Size frequency distributions of habitat and non-habitat polygons were quantified to evaluate changes in connectivity and fragmentation of habitat and non-habitats associated with successive implementation of the three land use scenarios considered in this report.

Three landscapes were simulated to assess the impact on total habitat/nonhabitat area and connectivity of implementing the three land use scenarios. Landscape 1 represented conditions prior to establishment of Cypress Creek NWR and the Joint Venture Area. Landscape 2 represented the impact of establishing the refuge and Joint Venture Area, and converting agricultural lands therein to natural communities (Scenario 1). Landscape 3 represented the impact of establishing forested riparian zones along all rivers and streams in the buffer area (Scenario 2) in addition to implementation of Scenario 1 (core area restorations).

We marked all existing forest and wetlands habitats within the core area to illustrate the current distribution and connectivity of existing habitats that are/will be protected within the core area. We then labeled all lands within the core

area as forest/wetland habitat under scenario 2 to simulate changes in habitat distribution associated with forest and wetland habitat restorations planned within the Joint Venture and National Wildlife Refuge boundaries. This was a modest simplification of projected change because 10 percent of the Refuge area will be left in agricultural production (Roelle and Hamilton 1992). Additionally, forest habitat restorations will occur over a long time span that was not accounted for in this simulation. We added the stream buffer areas as forest/wetland habitat to simulate implementation of scenario 3. Representation of this scenario assumed that all agricultural lands within riparian zones would be converted to permanent wooded cover; clearly an over-optimistic expectation. However, our simulation of this scenario illustrates the potential of this scenario to enhance connectivity of currently separated habitats, and to provide dispersal corridors and other landscape linkages between the core and buffer areas.

ECONOMIC ASSESSMENTS

To evaluate the economic impacts of a reduction in row crop acreage, increased nonresident demand for recreation services, response of local businesses to changes in recreation demand, and the capacity of the economy to meet a larger proportion of demand for recreation services we used a number of economic tools. These impacts were examined in a spatially diffused and sparse rural economy, making it difficult to identify and measure

secondary economic impacts (Beck et al. 1990). Our methods relied on identifying and quantifying the primary and secondary economic impacts resulting from transfers of land from agricultural production to production of wildlife / preservation / recreation services in the core and buffer areas.

The available tools for the analyst include regional I/O models, economic base methods, econometric models, or the accounting procedures embodied in cost-benefit analysis (Bendavid-Val 1991). These are the tools used by economists, regional planners, and project promoters in developing environmental and economic impact statements. In conducting this study we borrowed from all of these approaches, but concentrated on the use of a regional I/O analysis.

Regional I/O analysis (Miller and Blair 1985) was used to assess the primary, secondary, and induced economic impacts of the land use changes comprising the three scenarios described earlier. Specifically, we shocked the existing regional economy for each of the three land use scenarios. Given the shocks, we then examined the effects they had on the regional economy.

We used regional data to hybridize the IMPLAN regional I/O model (University of Minnesota) with technical coefficients and purchasing patterns appropriate for the region. Hybridization means the use of superior, local data to specify the nature of some of the economic relationships underlying the input/output model. Such data were derived from surveys of farm operators in the area, special tabulations of the 1987 Census of Agriculture,

Illinois Department of Revenue sales tax data tabulated by municipality, and recreational expenditure data from visitors to the Shawnee National Forest as well as similar wildlife/recreational areas. The greater the extent to which such local data can be incorporated into the IMPLAN model, the more reliable and accurate are estimates of the total, direct and indirect economic effects of an initial change in final demand for an individual sector within the region.

The structure of IMPLAN and the development of the IMPLAN model for the study region was described in detail in Beck et al. (1990). In the present study, we updated much of the data used and worked on hybridizing a number of the sectors in the model. Technical coefficients reflected productive relationships among sectors within the region, and the extent to which buyers of intermediate and final goods and services were willing to purchase regionally produced goods. For example, it must be recognized that in the process of producing agricultural commodities, the input sector made up of feed and seed dealers and other input suppliers is affected by the type of agricultural production in the region and the extent to which farmers purchase inputs and sell output locally. As farmers buy and sell locally, they generate economic activity that affects the nonfarm portions of the local economy. Similarly, when nonresident visitors to the area make purchases of goods and services they affect the local economy. In the case of our study, the change in land use from agricultural to recreation/wildlife changes the nature of

goods and services purchased and sold within the local economy; IMPLAN, as a regional input/output model permitted us to track these changes and determine their net effect on the economy.

In addition to the regional input/output model IMPLAN, we also used the Small Area Assessment Model (SAAM) (Robinson and Hickman 1990) to estimate the local economic effects of the recreational activity on retail sales volume, employment, and income. These variables can indicate trends in other variables of interest such as local government revenues and expenditures, population, and income distribution. The total change in each of the three variables was calculated as the sum of separately determined effects. Direct effects were those associated with the first round of spending. For example, if all people earning wages or salaries in recreational related retail trade, such as hotels and lodging places, hunting clubs, and eating and drinking places earn a total of $500,000 per year and the average propensity to consume is 0.80, then the direct effect was equal to $500,000 X 0.80 or $400,000. Induced effects were the additional subsequent changes in local economic activity captured by the multiplier process. For example, if the gross sales multiplier of the affected counties was 1.8, then the indirect effect in the region from a $400,000 direct change in sales was $400,000 * (1.8 - 1.0) = $320,000. The total economic impact was $500,000 + $400,000 + $320,000 = $1,222,000 for an implied total multiplier of 2.44.

After initial, direct, and induced impacts have been

estimated for each county in the study area, an adjustment was made for feedback effects. Feedback effects occur, for example, when two counties, say Jackson and Union export goods and services to each other. If an economic disturbance in Union County (increased demand for recreational services) increased the demand for services in Jackson county (hotel rooms), the increased use in Jackson county of hotel rooms may cause income in Jackson county to increase with a subsequent increase in the demand for the service provided by Union County. This, in turn, leads to additional repercussions in Jackson county. Impacts from these several sources are known as feedback effects. The adjustment procedure we used in SAAM consisted of applying regional multipliers to the direct change in income and employment calculated for the five counties of the local impact region (i.e., Alexander, Johnson, Massac, Pulaski, and Union counties) and for six counties in the outlying rural and urban areas (i.e., Jackson and Williamson Counties in Illinois, McCracken and Ballard Counties in Kentucky, and Mississippi and Cape Girardeau in Missouri). If the impacts for the eleven counties were greater than the sum of the impacts for the two groups of counties, then we knew that the feedback effects do existed. We anticipated the likelihood of this occurring to be quite large since the five county area in southern Illinois is economically sparse exhibiting few economic linkages among businesses within the region. Income generated within the region is spent elsewhere on goods and services and what is sold in the

region is produced outside of the region and imported into it.

ESTIMATION OF AGRICULTURAL IMPACTS

Farm level production data were derived from various sources. A significant source was the report by Beck et al. (1990) that extensively developed and checked farm level data. For the purposes of this study, those data were updated and more current production and price information was used. Additionally, a number of farm enterprise budgets relevant for the area prepared by the University of Illinois (Gingrich et al. 1991) and the University of Missouri (Moore 1991) were used. We made the assumption that all of the agricultural land in the core area would be in production (i.e., we did not allow for a set aside). Table 7 summaries some of the production data relevant for corn, soybeans, and wheat. Prices for corn and soybeans were the average December river prices on the Mississippi River between Cairo and St. Louis as published in Illinois Grain & Livestock Market News for the period 1982-1992. Wheat prices were from the same source for July. Prices used reflect market value of the commodities produced, not values used by the federal government to transfer money to farmers to support their income (see Gittinger 1982). Information on agricultural production in conjunction with information from IMPLAN and data on the structure of the local economy was then used to determine the impacts on various sectors of the economy of agricultural land in

Table 7. Production and Value of Grains, Five County Region

Crop	No. of Ha in Region	Average Yields Kg/Ha	Average Price/100 Kg	Crop Value Per Ha	Gross Crop Value/Yr. ($1,000)
Corn	5,532	6,171	$8.84	$543.03	3,012
Wheat	2,462	2,890	$11.15	$322.29	792
Soybeans	11,026	1,950	$22.40	$436.70	4,833

Source: Various annual summaries of Illinois Agricultural Statistics and various issues of Illinois Grain and Livestock Marketing News.

the core area moving out of agricultural production.

Given the information about agricultural production and the plans for establishing the national wildlife refuge and the other joint-venture activities in the core area, we projected a 15 year phase-in of core-area activities with 15,183 ha. eventually being included in the refuge-joint venture core. Assuming that the entire acreage would be acquired in fifteen years might be unrealistic; however, it gave us a basis for projecting the effects of the land shifting out of agricultural uses into recreational/wildlife uses. Table 8 summarizes our projected 15-year shift in land use in the core area. The data in the table reflect our estimation that there are approximately 9,474 ha. of row crops in the core area. The data also reflect the assumption that 10 percent of the agricultural land once acquired will remain in crop production under crop-share leases between local farm operators and the Fish and Wildlife Service. We projected that by the end of the fifth year approximately 40 percent, or 6,073 ha. of the core area, would be acquired. Of this acreage, 3,411 ha. would be taken out of agricultural production with the balance comprised of farmsteads, woods, and other nonagricultural uses. The direct effect of this acreage leaving agricultural production was estimated to be $1,544,324. The IMPLAN estimates of the total economic effects on the region's economy of this shift from agricultural land use was a loss of $2,087,700. By the end of the tenth year, we projected that 65 percent or 9,869 ha. of the core area would be acquired. The direct effect of the

Table 8. Agricultural Impacts of Establishing Recreation/Preservation Activities in Core Areas

		IMPACT SCENARIO		
Activity	TOTAL	YEAR 5	YEAR 10	YEAR 15
LAND ACQUISITION[a]		40%	65%	100%
Total land area (Ha)	15,183	6,073	9,869	15,183
Row crops (Ha)	9,474			
-10% FWS lease (Ha)	8,526	3,411	5,542	8,526
FEED GRAINS	29.1%			
Corn crop (Ha)	2,480	907	1,612	2,480
Impact per Ha[b]	$543.03			
Impact amount	($1,346,572)	($538,629)	($875,272)	($1,346,572)
FOOD GRAINS	12.9%			
Wheat crop (Ha)	1,124	441	717	1,124
Impact per Ha[b]	$322.29			
Impact amount	($355,719)	($142,288)	($231,218)	($355,719)
OIL CROPS	58.0%			
Soybean crop (Ha)	4,943	1,977	3,213	4,943
Impact per Ha[b]	$436.70			
Impact amount	($2,158,517)	($863,407)	($1,403,036)	($2,158,517)
NET DIRECT IMPACT	($3,860,808)	($1,544,324)	($2,509,525)	($3,860,808)
Total Effect of Agricultural Land Use Change	($5,219,249)	($2,087,700)	($3,392,570)	($5,219,249)

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[a] Assumes acreage purchases follow distribution of refuge boundary, GIS analysis.

[b] Assumes crop budgets follow national average costs of production and county average level of production.

5,542 ha. of this land being shifted out of agricultural production was estimated to be $2,509,525. The IMPLAN estimates of the total economic effects on the region's economy of this shift from agricultural land use was a loss of $3,392,510. Similarly, at the end of the fifteenth year, we projected that all 15,183 ha. would have been acquired for core-area activities with 8,526 ha. coming out of agricultural production. The direct effect of this shift in land use away from agriculture is estimated to be $3,860,808. The IMPLAN estimates of the total economic effects on the region's economy of this shift from agricultural land use was a loss of $5,219,249. The discerning reader will note that the implied output multiplier for this region is 1.35, (e.g., for every $1 loss of direct total output from the sector of production agriculture, an additional $0.35 is lost in related sectors in the region).

Economic impacts were developed for 405 ha, (i.e., 1000 ac.) units to assess effects of filter strips established to control sedimentation. These units included cropland converted from row crop production to production of cattle forages. Since the land in the proposed filter strips had formally been used for row crop production, we used the same information as for the core area to project the economic effects of shifting land from crop production to filter strips with forage. Since the forage on the filter strips could be harvested, we included a positive economic value for this in the budgets. We also assumed that farmers would use approximately 30 percent of the filter strips for

headlands, road ways, and other miscellaneous uses, hence out of every 405 ha. only 283 ha. would be available for harvest as forage. The direct effect of the establishment of 405 ha. of filter strips which had formally been in crop production was projected to be a negative $48,574. The IMPLAN estimates of the total economic effects on the region's economy of this shift from agricultural land use to filter strips was a loss of $77,600 per 405 ha.

The last shift in agricultural land use we evaluated was the shift from row crop production on highly erodible land to forage production which could be used as a cash crop or as an input for cattle production. The crop production data suggest that the shift to forage production on the highly erodible land would result in a net gain per acre of $9.18. Additionally, based on the structure of the IMPLAN model, if the 50 percent of the forage was used as pasture or feed for cattle, there would be a positive direct impact on the region's gross output of $502,713. Given the agricultural realities in the region, (e.g., distance from markets, prices and costs) we have reason to suspect the validity of these results. Given our analysis of the IMPLAN structure for its cattle sectors, we believe that it is seriously flawed and must be reconstructed to reflect the structure of cattle production and the forage markets in the study area (see Appendix Table 1 for a recently developed forage budget representative of the area). We have discovered that the cattle sectors of IMPLAN reflect two extremes of cattle production in

American agriculture: concentrated feed lots with large numbers of animals or cattle produced under range conditions with few animals per acre of land. Neither of these is typical of southern Illinois where cattle are produced in small numbers on a combination of pasture and forage. Fattening takes place in small herds or the young stock are sold to feed lots in other parts of the country. Further hybridization of the IMPLAN must be done to accurately reflect the economic effects of a shift from row crops to forage and cattle on highly erodible land. Since uncovering this problem, we have not had an opportunity to reconfigure this portion of the IMPLAN model, we have collected a portion of the economic data necessary to do so. We plan on accomplishing this restructuring in the subsequent phase of this research. Our educated guess was that the shift from row crops to a combination of forage/cattle production on highly erodible land would result in no significant changes in the level of agricultural activity in the region (i.e., the change in the region's gross output will be small or nonexistence). However, there might slight shifts in the impacts on input suppliers and the marketers of agricultural commodities.

ESTIMATION OF RECREATIONAL IMPACTS

Recreation impacts were based on conversion of 15,176 ha to public recreational uses, with 9,470 ha diverted from agriculture. Analysis assumed that residents will expand their economic activity over a 15 year period to provide recreation

services required by visitors. Recreation and tourism effects of a visitor center and development of private hunting clubs surrounding the refuge were also considered. Impacts on final demand, income at place of work, employment, and human population of the watershed were estimated after 5, 10, and 15 years.

Joint venture activity in the core area resulting in gradual land use changes may also improve the economic well-being of the local community. The presence of nationally known designated wildlands does attract tourism. Swanson (1969) discussed the role of national parks in causing an expansion of economic activity. Similar responses can be expected with respect to the creation of national forests and national wildlife refuges, and wilderness areas designated within them.

Recreation Supply - 1992

The following looks at the current supply of and demand for outdoor recreation in the Cache Basin. First, a description of recreation facilities currently available is presented. An assessment of present use follows.

The supply of outdoor recreation facilities in extreme southern Illinois is quite low when compared to the rest of the state and to other parts of the nation. State and federal lands are well represented, but recreation lands on the local level are almost non-existent.

Federal. The two agencies with a presence in the region are

the U.S. Army Corps of Engineers and the USDA Forest Service. The Corps is responsible for management of navigation on the Ohio River, and as such, provides very basic facilities for users of the river. These include opportunities for fishing and boating, etc. on the river pools as well as access to the river for the launching of watercraft.

A portion of the Shawnee National Forest is within the five county area (Table 9). Nearly one-third of the total forest area is within the Cache Basin study area. Literally all national forest acreage is open for dispersed recreation including hunting, fishing, and hiking. Designated recreation sites include the Pine Hills Ecological Area in Union County, the Grapevine Trail in Alexander County, and Dutchman's Lake and Lake of Egypt in Johnson County. More than 4,049 ha. of the Forest Service ownership in the five-county region is designated wilderness. Bald Knob and Clear Springs Wilderness Areas in Union County were established in November, 1990. Motorized recreation and other motorized equipment and vehicular access are prohibited.

State. It has been the goal of the Illinois Department of Conservation to establish a state park unit in each Illinois county. That goal has been met in each of the five study counties. The state park facilities are described in Table 10. All the state-managed areas are open for various types of dispersed recreation. Most have picnic sites and toilets.

Table 9. Shawnee National Forest Ownership By County

County	USFS Ownership (Acres)
Alexander	24,797
Johnson	18,471
Massac	2,703
Pulaski	0
Union	35,099
Total Within Region	81,070

Percent of Shawnee NF within region--30.8%

Source: USDA Forest Service, Shawnee National Forest (n.d.)

Table 10. Illinois Department of Conservation Ownership by County

County/Sites	Acreage	Camping	Hunting	Fishing
Alexander County				
Horseshoe Lake Conservation Area	9550	X	X	X
Johnson County				
Ferne Clyffe State Park	1100	X	X	X
Massac County				
Fort Massac State Park	1499	X	X	X
Mermet Lake Conservation Area	2580	X	X	
Pulaski County				
Cache River State Natural Area	8214		X	X
Union County				
Union County Refuge	6202		X	X
Trail of Tears State Forest	4993	X		X

Source: Illinois Department of Conservation (1991)

Local. Recreation facilities are generally not provided by local government in the region. The communities are small and the tax base to support recreation is limited. However, some towns provide picnic sites, playgrounds, sports facilities, and toilets. These, however, are primarily for residents of the specific community.

Private. The region of analysis is primarily in private ownership, rural in nature, and conservative in philosophy. McCurdy (1992) found that in the southernmost 15 counties of Illinois, the primary land use was the production of grains and/or livestock. He further noted that recreation was increasing as a major reason for holding land. In 1977, five percent of the landowners noted recreation as the primary reason for holding land; by 1991, it was up to 12 percent.

Private landowners make substantial use of their own land for recreation purposes; 16 percent of the total acreage is held for recreation (McCurdy 1992). However, most private landowners do so for themselves or their families and friends. Few open their land to the public out of fear of liability or concern for damage to property. No data are available as to the amount of private land open to the public.

The Nature Conservancy has opened its Lower Cache River Preserve for public access. The area, bordering the south shore of the Cache River, contains 810 ha. that are open

to hikers and other outdoor recreationists. The Limekiln Springs Trail offers access into the area with improved surfaces and interpretive signing.

Recreation Supply Needs. The Department of Conservation in Illinois periodically publishes a needs assessment by county. Of the five counties in the region, all but Massac are considered to have sufficient acreage open for outdoor recreation. Considering specific facilities, however, there are some substantial deficiencies. The biggest deficits seem to be in the provision of trails and facilities for lodging. Hunting and fishing opportunities are adequate. Massac and Pulaski Counties have the biggest needs when considering all forms of recreation. Table 11 provides a summary of needs for outdoor recreation by county, using IL Department of Conservation categories.

Summary of supply. There appears to be ample land available for recreation in the five-county region. Opportunities for hunting and fishing are sufficient for the foreseeable future There are, however, gaps in facilities available.
There is a definite lack of trails in the region. Lodging is also lacking, to the point where any increases in tourism will be constrained by the lack of facilities to feed and house travelers. In sum, the focus of recreation should be on more intensive development of existing areas.

Table 11. Recreation Needs by County

Activity	Alexander	Johnson	Massac	Pulaski	Union
Fishing			X	X	
Swimming	X		X	X	X
Hunting			X	X	
Campsites			X	X	
Cabins/Lodges	X	X	X	X	X
Trails	X	X	X	X	

Source: Illinois Department of Conservation (n.d.)

Recreation Use - 1992

The following presents the current levels of recreational activities within the five county region. Data come mostly from agency records and from interviews with individuals living in the region with first-hand knowledge of regional recreation use.

A major difficulty in analyzing use figures is that they are compiled in two different ways: by counts at entrance points or by estimating use by activity. Another consideration is that some figures are expressed by visits (i.e., the number of people who actually enter a park) while others are expressed as visitor-days. The latter is any combination of 12 people-hours (e.g., 3 persons at 4 hours each, 6 persons at 2 hours each, etc.) (Table 12).

Federal. The latest data for the U.S. Forest Service were compiled in 1991. They are presented by state but the Shawnee National Forest is Illinois' sole national forest. Unfortunately, use data are not presented by county but if one assumes that each acre of the forest has similar recreation use, total forest figures multiplied by .308 (see Table 9) would give a good approximation of recreation use on the Shawnee National Forest within the five county region.

Data were also presented for the previous five years. Figures for 1991 were down almost 50 percent from 1990 and 11 percent from 1989. The figures for 1991 were the lowest

Table 12. Estimated Use--USFS Acres Within Five County Region by Activity

Activity	RVD[a]
Camping, Picknicking and Swimming	54.4
Viewing Scenery	100.3
Hiking, Horseback Riding	40.3
Winter Sports	0.2
Resorts and Cabins	2.3
Hunting	37.5
Fishing	9.1
Non-consumptive Wildlife	3.1
Total	259.8

---

[a] RVD = Recreation Visitor Days in thousands (12 people hours)

Source: USDA Forest Service (1992)

since 1987.

State. The Illinois Department of Conservation compiles use figures for state recreation areas based on traffic counts, camping receipts, and estimates of other use. Use for the period 1987-1990 are presented in Table 13.

Use figures for the Cache River State Natural Area were obtained from an interview with park staff (Personal communication Jim Wyculis, November, 1992). Total estimated use for September, 1991 through September, 1992 was 30,020 visitors at developed areas (Heron Pond, Little Black Slough) and approximately an additional 1,000 hunters in the undeveloped portion of the natural area.

As with the Forest Service data, use dropped in the period 1990-1991, with several areas reporting fewer visits in 1990 than in 1987. The role of the national economy in reduced tourism was a major causal factor.

Another factor was the decline in the popularity of hunting in the region. Whitton (1992a) reported that goose hunting declined substantially for the period 1977-1991. Data for Horseshoe Lake and Union County are presented graphically in Figure 5. Harvests of ducks also declined as shown using data for Mermet Lake Conservation Area (Whitton 1992b). These figures are consistent with the decline in hunting nationwide.

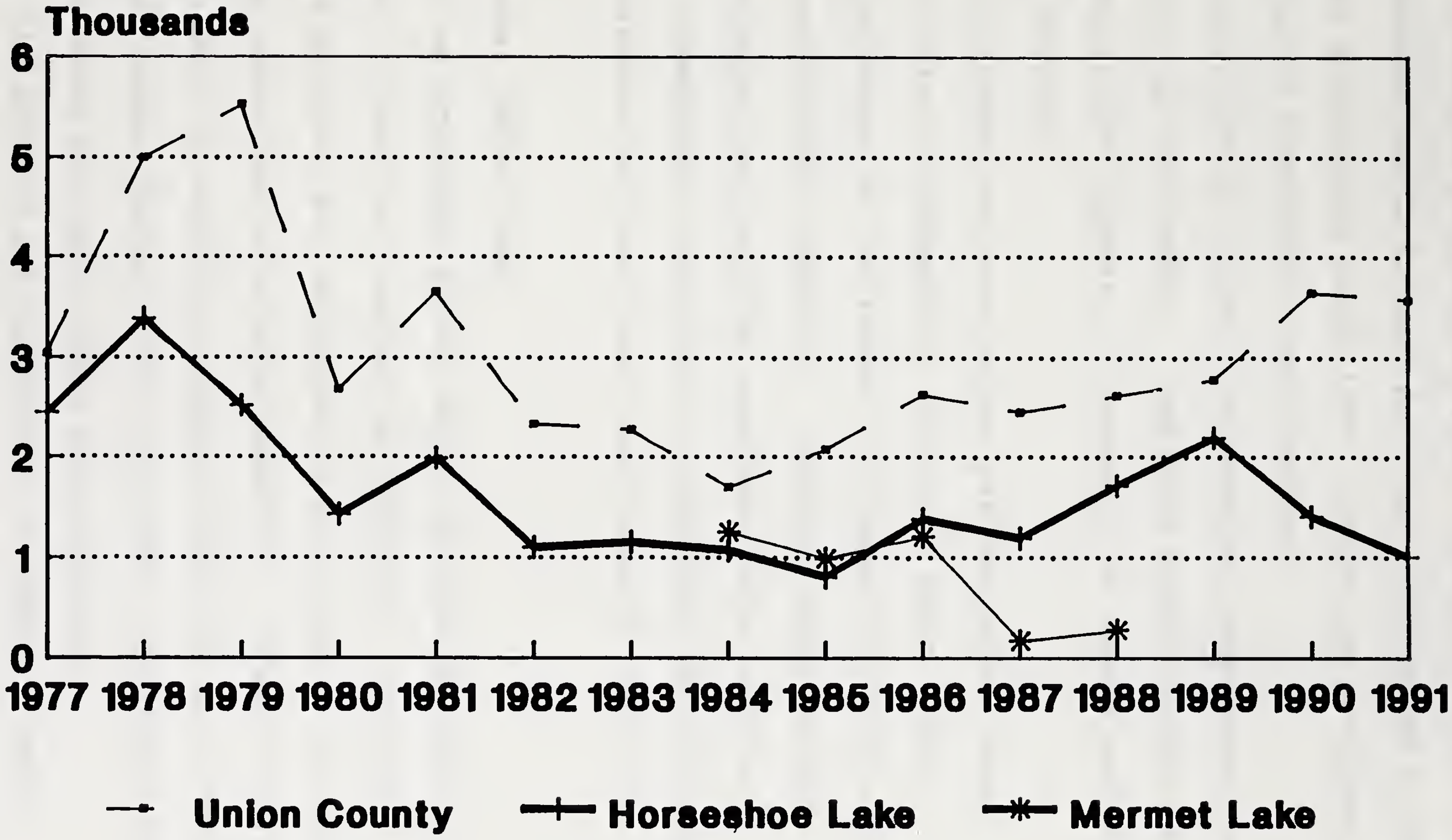
Table 13. Region State Park Use--1987-1990.
(Thousands of Visits)

Park	1987	1988	1989	1990
Ferne Clyffe	241	301	266	221
Horseshoe Lake	248	255	251	218
Fort Massac	847	986	1,466	1,420
Mermet Lake	159	155	180	160
Union County	72	---	5	33

Figure 5.

Hunter use in areas of the
Cache River Watershed

Hunter Use
Cache Basin Areas



Private lands. There is substantial recreation activity taking place outside developed recreation sites. Unfortunately, no survey of recreation participation has been provided on a county by county basis in Illinois since 1976. There are available more recent estimates of recreation participation in selected activities by Illinois households, aggregated for the entire state (IL DOC 1989a). Combining participation rates with county population figures, an estimate of county participation can be derived.

Table 14 displays the most recent participation rates for those activities of concern in the Cache Basin. Also included are estimates of the number of visitor-activity days the average user consumes annually. Finally, using current population estimates for the five counties, total visitor-activity days consumption estimates are presented by activity. Population estimates for each county are found in Table 15.

Visitor Use Data: IMPLAN Input

The data, as presented above, cannot be used directly by IMPLAN. First, it must be compiled by activity. The state data were collected by area, but estimates of use by activity were prepared using interviews with site managers. Forest Service data were available by activity. Second, data were not available for 1991 in all cases. Using recent trend data, estimates for 1991 were made using the most recent data available.

Finally, the private data presented in Table 14 were

Table 14. Estimates of Local Participation in Selected Activities

Activity	Percent of Adults Participating	Mean Visitor Activity Days	Use Within Region (1,000VAD)[a]
Driving for Pleasure	58.8	27.8	1,041
Wildlife Observation	28.1	20.9	374
Picnicking	50.3	5.8	186
Canoeing	8.6	4.3	24
Hiking	12.4	7.8	62
Horseback Riding	8.1	8.4	43

---

[a] VAD = Visitor Activity Day

Source: Illinois Department of Conservation (1989a)

Table 15. Population and Population Change Within Five County Region

County	Population	Percent Change 1980-86
Alexander	11,400	-7.4
Johnson	10,900	13.2
Massac	14,900	-0.7
Pulaski	8,500	-4.4
Union	18,000	1.6
TOTAL	63,700	+0.003

Source: Illinois Department of Conservation (1989b)

not included in the totals for IMPLAN. The reasons for this decisions include the following: (1) lack of any solid data specific to the five county region for use outside designated recreation sites, and (2) the minute contribution of such recreation trips to the local economy. For the latter, very few of the trips computed would have included an overnight stay, very few would have been far from home, or involve much expense to the user. Hence, due to the lack of hard data and the small impact estimates would have on IMPLAN, it was deemed appropriate to use only the data collected by on-site managers.

In Table 16 are the estimates of 1991 recreation use in the five county area. The categories used are those required by IMPLAN. Estimates are the summations of use for federal and state areas within the region. Data for hunting/excluding waterfowl were compiled using deer harvest data combined with estimates of upland game hunting provided by on-site managers.

The importance of the analysis of the Cache Basin is to help plan for the future. Establishment of Cypress Creek National Wildlife Refuge set in motion changes in ownership that will have economic and social affects within the region.

Following is an analysis of how recreation may change in the next 15 years. The first portion of the analysis discusses the factors that cause change over time and relates them to expected changes within the five county region. The final portion provides estimates of what recreation will be in the future in the region. This is combined with a discussion of

Table 16. Recreation Use Estimates--1991 Cache River Basin

Activity Class	VAD[a]
Non-consumptive Recreation	1,524
Hunting/Waterfowl	35
Hunting/Excluding Waterfowl	54

---

[a] VAD = Visitor Activity Day, one thousand visitor-acitivity days

factors that may cause estimates to vary.

There are numerous factors that determine the demand for outdoor recreation (Clawson and Knetsch 1966; Gregory 1972). These factors may be classified as characteristics of the individual (age, income, occupation, etc.) or societal characteristics. For purposes of the Cache Basin, the latter will be addressed.

Population. One of the factors causing an increase in the consumption of recreation is an increasing population. As total population increases, recreation does likewise. In the case of the Cache Basin, total population growth is minuscule. Table 15 summarizes the estimates of population for all five counties and suggests how that population has changed in the recent past.

Population in the five county region can be expected to remain relatively constant or decline slightly. This assumes that in the planning period of 15 years, some major change in society does not occur. For example, it assumes that the region will not become a mecca for retirees.

In sum, the population of the Cache Basin will not cause any major increases in recreation demand from within. Growth in recreation use, therefore, if it is to occur, must come from elsewhere in Illinois or from surrounding states.

Participation Rates. Recreation use rates will increase if

individuals increase their per capita consumption of an activity. There are no specific data for the Cache Basin, but there are figures for Illinois. The Illinois Department of Conservation has compiled changes in participation rates for the period 1985-1989. These results are shown in Table 17. Nearly all rates of participation declined during that period except for non-consumptive uses of wildlife (nature study, bird watching, etc.). The rates of decline were significant in some cases. Other than driving for pleasure, one would not expect major increases in recreation use due to changing use patterns. Again, increases by activity must come from attracting additional visitors from outside the region.

Access. Ease of access can be a significant factor in recreation demand. The greater the ease of access, the more likely an area will be used for recreation. The Cache Basin is served by two interstate highways with easy access to Chicago, Memphis, New Orleans, and Nashville. State highways and secondary roads are, for the most part, in good condition. Though the area's access is not likely to be improved in the near future, it is not now a limiting factor and likely will not be any time soon.

Opportunity. The demand for outdoor recreation is greatly affected by the opportunity to actually participate in a specific activity. Individuals have preferences for particular activities, but will accept substitutes in their

Table 17. Changes in Rates of Participation--Illinois 1985-1987-1989

Activity	Rate of Participation in Percent by Year 1985	 1987	 1989	 Significance
Driving for Pleasure	n.a.	66.6	58.8	---
Wildlife Observation	14.3	27.3	28.1	.01
Picnicking	n.a.	58.2	50.3	---
Canoeing	9.2	9.5	8.6	ns
Hiking	19.0	13.9	12.4	.01
Horseback Riding	11.2	10.0	8.1	.05
Hunting	5.8	6.7	6.6	ns
Fishing	28.8	30.0	26.6	ns

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na = not available

ns = not significant

Source: Illinois Department of Conservation (1989a)

absence. There are now four state park units with campgrounds and two U.S. Forest Service campgrounds in the basin. Neither management agency plans any new or expanded camping facilities. Cypress Creek National Wildlife Refuge will not have any camping facilities. None of the existing campgrounds have facilities for motor homes or travel trailers (i.e., there are none with sewer and water hook-ups). These are used by the more affluent travelers, and at present, there are no facilities for them in the area. Public agencies typically do not provide such facilities. Therefore, future developments must come from the private sector.

The Illinois Department of Conservation has completed a canoe access point near Perks with a marked canoe trail, a landing pier, and a parking area with toilets and interpretive signing. A private launching area exists at Perks. No canoe rental firms exist at present.

As noted above, ample hunting opportunity exists within the region. Public hunting areas are managed by the U.S. Forest Service and the state. Many residents hunt on their own land. With hunting growing only modestly, if at all, there does not seem to be any lack of hunting opportunity in the future.

The fishery in the Cache River has declined due to activities of humans, but remains substantial. The Cache receives an influx of fish from the Mississippi and the Ohio when they are in periods of high water. The fishery may be improved

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

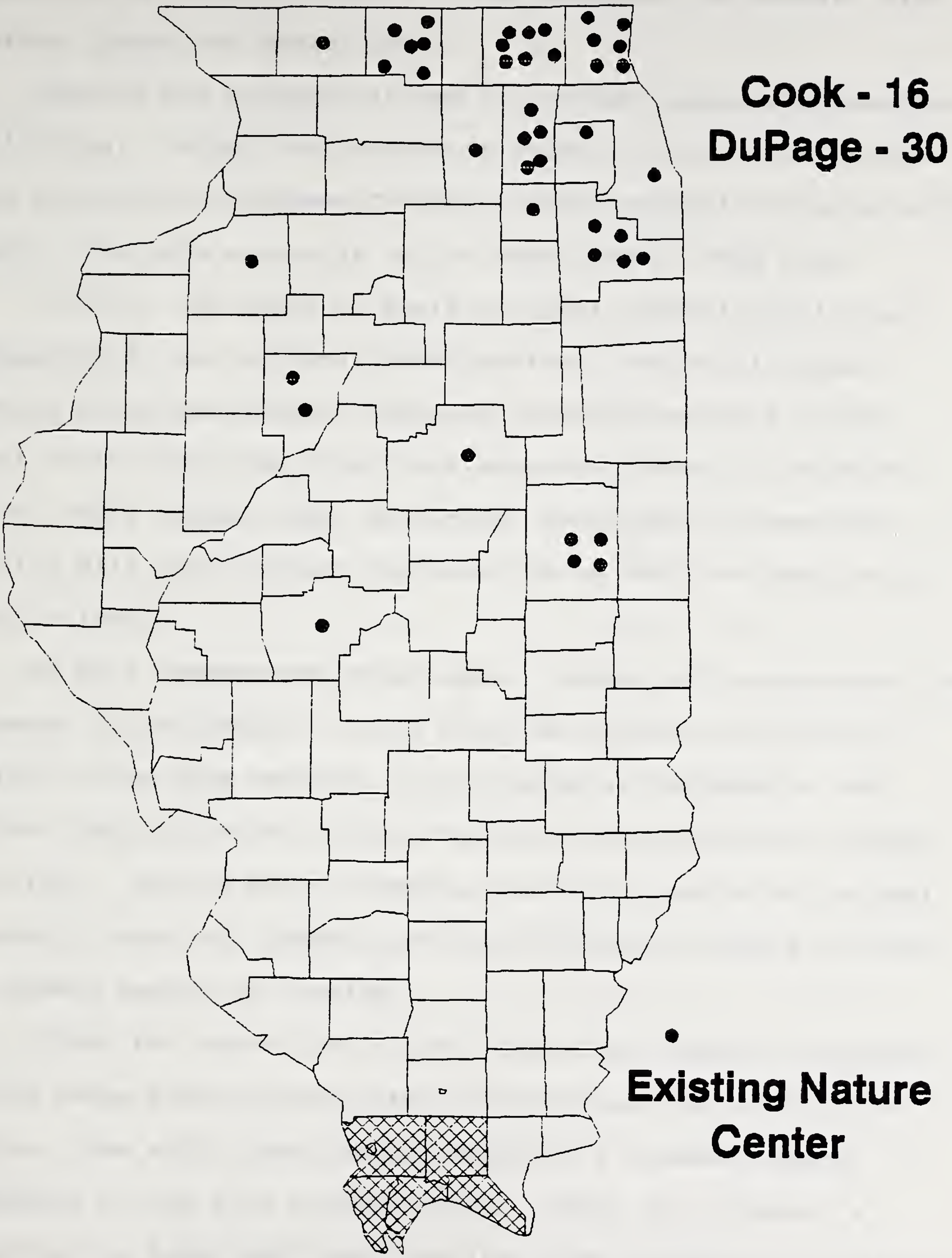
in the future if funds are available. Nonetheless, the Cache will continue to be a significant opportunity for the region's fishers.

Developed trails exist in the Shawnee National Forest, in the Cache River State Natural Area, and in The Nature Conservancy's Lower Cache River Preserve. These are described in McPherson (1993). Trails are a major means of access for visitors and are especially useful in getting people away from their vehicles to enjoy the natural environments of the region. According to the state's needs assessment, more trails are necessary. The visitor/nature center proposed for Cypress Creek will likely include new trails developments.

The development of Cypress Creek National Wildlife Refuge will include a visitor/nature center complex. The facility will include exhibitory, audio visual facilities, and associated trails. In addition, the center will function as a regional nature center. There are no such facilities in Illinois south of Springfield (see Figure 6) and none in the region except for Woodlands Nature Center at the Tennessee Valley Authority's Land Between the Lakes. Woodlands has been shown to be a significant attraction to Land Between the Lakes. More than one-third of its visitors are long distance travelers along Interstate-24. Such

Figure 6.

Location of nature centers in Illinois



Illinois Nature Centers

a facility at Cypress Creek has the potential for similar visitation (Burde and Howatt 1993).

Driving for pleasure is one of the most popular recreation activities. Primary and secondary roads in the region provide ease of access to Cypress Creek and other natural features of the region. No data exists as to the magnitude of this use.

In 1985, the Trail of Tears National Historic Trail was designated by the National Park Service. The trail passes through Union and Johnson Counties, and commemorates the removal of the Cherokee from their ancestral lands to Oklahoma. As the Trail becomes more developed, additional recreational driving will occur within the Cache Basin (USDI National Park Service 1985).

As with campgrounds noted above, motels and restaurants are uncommon in the region. Aside from the visitor services in nearby cities like Paducah, Cape Girardeau, Carbondale, and Marion, the only motels within the region are in Cairo, Vienna, and Ullin. Eating establishments are widely scattered as well. In short, there are insufficient facilities at present to serve any modest amount of tourism.

Given the above discussion, demand for outdoor recreation in the Cache Basin is not likely to increase from within the region. Use will likely remain relatively constant among residents of the five county region. There is, however, a potential to draw additional tourists from elsewhere in Illinois and from tourists on longer trips. It is difficult to predict

how large that increase might be. The major determining factors are the likelihood of development of an infrastructure to support tourism and the ability of the public and private interests to adequately publicize the presence of this unique natural environment. A projection of what might happen over the next 15 years follows.

Future Use: 5, 10, and 15 Years (Table 18)

General recreation. There is little reason to suspect that general recreation use will increase in the first five years of analysis. The factors of demand are such that no significant increase in use would likely result. Second, the supply of outdoor recreation opportunity will not change except for the acquisition of additional acreage for Cypress Creek National Wildlife Refuge. This additional acreage in reality, however, will increase opportunity only marginally.

The opening date of the proposed nature/visitor center is unknown at this point, and even if it is completed, awareness of it among potential users will be small. Also, it is highly unlikely that any substantial development of tourist facilities will take place. Therefore, we assume only a five percent increase in recreation in five years, with the increase due mainly to the favorable perception of visitors to wildlife refuge designation.

By the end of the tenth year, the possibility of an expanded tourist infrastructure is much more likely. There-

Table 18. Projections of Future Recreation Use in the Cache Basin

Use Type	1991	Years Hence 5	 10	 15
	(Thousands of Users)			
General Recreation	1524	1600	1760	1970
Hunting/Waterfowl	35	37	40	45
Hunting/Except Waterfowl	54	56	59	64

fore, a ten percent increase in tourism is possible. The nature/visitor center will be open by then and likely will have become better known among the traveling public.

In the fifteenth year, a even greater increase is projected. The optimistic scenario would be that the private sector has invested in campgrounds, motels, and other tourist facilities. The nature/visitor center is attracting large numbers of travelers off both interstate highways in the region. The ecological changes in the refuge itself are now becoming pronounced (i.e., the cypress forests are beginning to acquire the appearance of a functioning cypress wetland ecosystem, and the habitat for associated wildlife has improved, providing an attraction for tourists).

One must also consider the pessimistic scenario of no significant infrastructure development which would result in travelers not being able to stay in the area, even if the physical attractions beckon. If tourists have no opportunity to stay in the area, then no economic benefits will accrue to the region.

There is another consideration that may be a positive factor on future demand. The introduction of riverboat gambling in Metropolis, Illinois in March, 1993, will attract thousands of tourists to the region. With proper marketing and facilities to support them, these tourists may wish to take advantage of the region's natural beauty as well. However, in places like Gatlinburg, Tennessee, there is a

clientele of tourists that visit the city, but make no use whatsoever of the adjacent Great Smoky Mountains National Park. The role of gamblers in overall tourism in the Cache Basin is yet to be seen.

Hunting - waterfowl. As noted above, hunting opportunity in the Cache today is ample for existing demand. Demand from among local residents will likely not increase. In fact, it may actually decline. Any increases in demand can come only from outside the region.

The presence of the refuge will greatly improve habitat, especially for ducks, and consequently will improve hunting opportunity. Such opportunity will likely attract hunters from elsewhere in Illinois and adjacent states, especially if the opportunity is made known to others through the various media outlets.

Therefore, we are projecting a slow increase in hunting use over the next 15 years. This growth will coincide with the improvement of habitat (and hunting opportunity) brought about by the land restoration techniques being used on the newly acquired refuge.

Again, the magnitude of the growth will depend in part, on the availability of support facilities in the region. Hunters need food and lodging, and their length of stay and probability of returning will be determined by the quality of their experience. That quality is a function of the

quality of the hunt, but also of the amenities of their stay.

Hunting - non-waterfowl. As with waterfowl hunting, opportunity for non-waterfowl hunting in the Cache Basin is not lacking. There appears to be ample acreage, public and private, available for hunters seeking deer and other small mammals, as well as upland game birds. Demand for these forms of hunting will not likely increase among local residents.

Demand may increase from additional use from outside the region, but this increase will likely be less, on the basis of percent, than with waterfowl hunting. The main reason is that the improvement in habitat related to the creation of Cypress Creek National Wildlife Refuge is primarily directed toward waterfowl in general, and ducks in particular. Improvement in habitat for mammals and upland game birds will also be improved, but in a more indirect fashion.

Estimation of the Economic Effects of Recreational Impacts -- Basis for IMPLAN Analysis

Using an optimistic scenario, demand for outdoor recreation within the Cache Basin will likely grow over the 15 year planning period. Growth will primarily be in the non-consumptive uses of land including driving for pleasure, hiking, picnicking, and nature study. Demand for hunting

will grow as well, but at a slower rate.

A more pessimistic view is that recreation demand will grow, though at a much slower rate. This would be caused by a lack of development in the facilities and services to support tourism. These are not available in the region at the present time.

The ultimate scenario will be determined by perceptions of potential investors. If they perceive that the opportunity to create a profitable enterprise exists, additional facilities to attract tourists will be created, which in turn would create additional opportunities for investment, and so on. The threshold of recreation use, beyond which investors will risk capital, is indeterminate at this point. For the Cache Basin to prosper from recreation, that threshold must be crossed.

The data just presented on recreation were translated into a form that could be used by IMPLAN to assess the recreational impacts on the economy of the region. Data on visitors separated into different classes, type of expenditures, and level of expenditure were developed and are summarized in Tables 19, 20, and 21. Table 19 presents data on the expected level of visitation to the area by different classes of visitors: nonconsumptive visitors to the five county region, waterfowl hunters within the core area, nonwaterfowl hunters within the core area, and visitors to buffer area hunting clubs. For each of these groups, estimates were developed as to their level of

Table 19. Expected Visitors to the Core Area and the Five County Region.

		Core Area		Buffer Area
Year	Nonconsumptive Visitor-Days (Number)	Hunting/ Water Fowl Visitor Days (Number)	Hunting/Except Water Fowl Visitor Days (Number)	Waterfowl Hunting Clubs Visitor Days (Number)
Base Year (1991)	1,524,000	35,000	54,000	unknown
Year 5	1,600,000	37,000	36,000	2,000
Net Increase over 1991	76,000	2,000	2,000	
Year 10	1,760,000	40,000	59,000	5,000
Net Increase over 1991	236,000	5,000	5,000	
Year 15	1,970,000	45,000	64,000	10,000
Net increase over 1991	446,000	10,000	10,000	

Table 20. Summary Data for Determining Recreational Impacts in Core Area

		Impact Scenario		
Activity/Expenditure	1991	Year 5	Year 10	Year 15
A. Non-Consumptive	1,524,000	1,600,000	1,760,000	1,970,000
Net Increase over 1991		76,000	236,000	446,000
	Expenditure	LPC[a]	LPC[a]	LPC[a]
Food and Drink	$5.05	60%	70%	85%
Transportation	$2.91	50%	60%	75%
Lodging or Camping	$1.33	60%	70%	85%
Equipment	$6.47	30%	40%	50%
Guide Fees	$0.16	80%	85%	90%
Special Expenditure	$0.14	50%	55%	60%
Total per VAD[b]	$16.06			
Total Expenditure	$24,475,440	$1,220,560	$3,790,160	$7,162,760
B. Hunting/Waterfowl	35,000	37,000	40,000	45,000
Net Increase over 1991		2,000	5,000	10,000
	Expenditure	LPC[a]	LPC[a]	LPC[a]
Food and Drink	$21.42	60%	70%	85%
Transportation	$10.09	50%	60%	75%
Lodging or Camping	$10.52	60%	70%	85%
Equipment	$6.47	30%	40%	50%
Guide Fees	$0.47	100%	100%	100%
Special Expenditure	$1.32	50%	55%	60%
Total per VAD[b]	$50.29			
Total Expenditure	$1,760,150	$100,580	$251,450	$502,900
C. Hunting, other	54,000	56,000	59,000	64,000
Net Increase over 1991		2,000	5,000	10,000
	Expenditure	LPC[a]	LPC[a]	LPC[a]
Food and Drink	$6.04	60%	70%	85%
Transportation	$4.81	50%	60%	75%
Lodging or Camping	$3.13	60%	70%	85%
Equipment	$7.17	30%	40%	50%
Guide Fees	$0.47	80%	85%	95%
Special Expenditure	$1.00	50%	55%	60%
Total per VAD[b]	$22.62			
Total Expenditure	$1,221,480	$45,240	$113,100	$226,200

Continued

Table 20, Continued

Total Expenditure A+B+C		$1,366,380	$4,154,710	$7,891,860

		Impact Scenario		
Activity/Expenditure	1991	Year 5	Year 10	Year 15
D. Local Expenditure Totals for A, B, & C above.				
Food and Drink		$263,232	$930,370	$2,147,865
Transportation		$125,480	$456,756	$1,085,145
Lodging or Camping		$77,028	$267,491	$620,228
Equipment		$254,044	$638,048	$1,511,010
Guide Fees		$11,420	$36,444	$73,389
Special Expenditure		$7,640	$24,552	$51,384
Total Local Expenditures		$738,844	$2,353,661	$5,489,021
E. Apportioned to IMPLAN Sectors and Local Expenditure Totals Distributed				
Other Wholesale Trade		$85,765	$277,943	$646,777
Other Retail Trade		$79,219	$221,044	$519,617
Hotels and Lodging Places		$77,028	$267,491	$620,228
Eating and Drinking Places		$193,739	$684,752	$1,580,829
Auto Repair and Services		$75,288	$274,054	$651,087
Hunting Guides/Club		$11,420	$36,444	$73,389
Total Net Local Impacts		$522,458	$1,761,728	$4,091,927

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[a] LPC: Local Purchase Coefficient indicating the proportion of nonresident demand that is met by local business establishments.

[b] VAD: Visitor Activity Day is one visitor per one activity day

[c] Apportionment is achieved on the basis of margining the level of expenditure to the appropriate IMPLAN sectors.

Source: Missouri Dept. of Conservation (1989)

Table 21. Summary of Data for Determining Recreational Impacts in the Buffer Area

Activity/Expenditure			Impact Scenario's	
A. Off-Refuge Visits	1991	Year 5	Year 10	Year 15
(Hunt Clubs)	Unknown	2,000	5,000	10,000
	Expenditure	LPC[a]	LPC[a]	LPC[a]
Food and Drink	$21.42	60%	70%	85%
Transportation	$10.09	50%	60%	75%
Lodging or Camp	$10.52	60%	70%	85%
Equipment	$6.47	30%	40%	50%
Club Fee and/or	$46.64	100%	100%	100%
Special Expenditure	$1.32	50%	55%	60%
Total per VAD[b]	$96.46	$192,920	$482,300	$964,6000
Total Expenditures				
B. Local Expenditure				
Food and Drink		$25,704	$74,970	$182,070
Transportation		$10,090	$30,270	$75,675
Lodging or Camp		$12,624	$36,820	$89,420
Equipment		$3,882	$12,940	$32,350
Guide Fee's or Licenses		$93,280	$232,200	$466,400
Special Expenditure		$1,320	$3,630	$7,920
Total Local Expenditures		$146,900	$391,830	$853,835
Local Percentage of Total		76.15%	81.24%	88.25%
C. Locale Expenditure Totals Distributed and Proportional to IMPLAN Sectors.				
Food and Drink		$6,226	$18,349	$44,696
Transportation		$2,968	$9,027	$22,061
Lodging or Camp		$12,624	$36,820	$89,420
Equipment		$18,918	$55,178	$134,004
Guide Fee's or Licenses		$6,054	$18,162	$45,405
Special Expenditure		$93,280	$233,200	$466,400
Total Net Local Impacts		$140,070	$370,736	$801,985

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[a] LPC: Local Purchase Coefficient indicating the proportion of nonresident demand that is met by local business establishments.

[b] VAD: Visitor Activity Day is one visitor per one activity day

[c] Apportionment is achieved on the basis of margining the level of expenditure to the appropriate IMPLAN sectors.

Source for expenditure data in part A is the Missouri Dept. of Conservation (1989)

spending by category of expenditure per visitor activity day (VAD). Additionally, we projected the proportion of these expenditures by nonresident visitors that would be captured locally (local purchase coefficient (LPC)). We adjusted the LPC across time to capture the effect of more of this activity being realized by businesses within the region (see Tables 20 and 21).

The expenditures were then distributed among IMPLAN sectors so the expenditures could be used to impact the local economy. This also involved the "margining" of the expenditures to capture only that portion of a local expenditure resulting in net economic activity to the region's economy. This line of reasoning is derived from the National Income and Product Accounts value added procedures (e.g., only the value added portion of a visitor's expenditure can be attributed to local economic activity and allowed to enter IMPLAN).

In addition to the data on expenditures by classes of visitors to the region, economic data were collected on the projected levels of employment by new activities in the core area (Table 22). Based on discussions with personnel of the Fish and Wildlife Service and The Nature Conservancy, we projected that activity in the core area would result in 20 new full time equivalent jobs with an average level of compensation of $26,000 per year. Given projections for the development of a visitor center at the Cypress Creek National Wildlife Refuge, we looked at the impact of a $5,000,000 center with an annual operations and maintenance budget.

Table 22. Summary Data on Refuge/Visitor Center: Operation and Maintenance

Source of Employment	Full Time	Part Time	F.T.E.[a]
Refuge	8	0	8
Visitor Center	2	6	3.5
T.N.C.[b]	4	6	5.5
I.D.O.C.[c]	2	4	3.0
Total Employment			20
Employee Compensation	$26,000/Per Year		$520,000

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[a] Full Time Employment

[b] The Nature Conservancy

[c] Illinois Department of Conservation

RESULTS OF ANALYSES

Ecological Assessment

Current conditions. The current landscape is characterized by a broad expanse of agricultural lands that dominate the Cache River watershed (Figure 7). The predominantly agricultural landscape is broken only by roads and other features that were not identifiable at our scale of analysis. Except for scattered agricultural areas less than 4 ha in size, the current landscape is a large contiguous block of cropland and herbaceous cover that extends over 110,000 ha (Table 23). Parcels of forest and wetland habitats averaging 12 ha in size are scattered within a matrix of agricultural land. The largest block of contiguous habitat (9,205 ha) is upland forest that occurs within the hills of the Shawnee National Forest in the western edge of the watershed. The corridor of habitat that is the remnant of the formerly extensive Cache River wetlands and bottomland forest stretches along the river in a series of distinct and elongated patches. Nearly 5,800 parcels account for a total of about 67,600 ha of habitat.

Row cropland comprised nearly half of the current land use/land cover of the Cache River watershed; upland forest accounted for 25 percent of the watershed area (Table 6, Figure 7). Human developments (mines/quarries, urban areas, transportation features) covered 2.3 percent of the area,

Table 23. Changes in Total Areas, Mean Numbers, and Parcel Sizes of Habitat[a] and Nonhabitat[b] Community Types Anticipated from Succesive Implementation of Land Use Scenarios in the Cache River Watershed in Southern Illinois.

Parcel Characterization	Landscape 1[c]		Landscape 2[d]		Landscape 3[e]	
	Habitat	Nonhabitat	Habitat	Nonhabitat	Habitat	Nonhabitat
Parcel Size (Ha)						
Mean	11.7	69.6	15.1	68.2	26.4	46.2
Range	1-9,205	1-110,409	1-22,685	1-113,636	1-77,322	1-15,684
No. Parcels	5,787	1,819	5,338	1,667	3,552	2,172
Total Area (Ha)	67,641	126,550	80,576	113,636	93,755	100,464

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[a] Habitat was defined as upland forest, lowland forest, swamps, and other wetlands.

[b] Nonhabitat was defined as agricultural, urban, herbaceous, and other developed land use types.

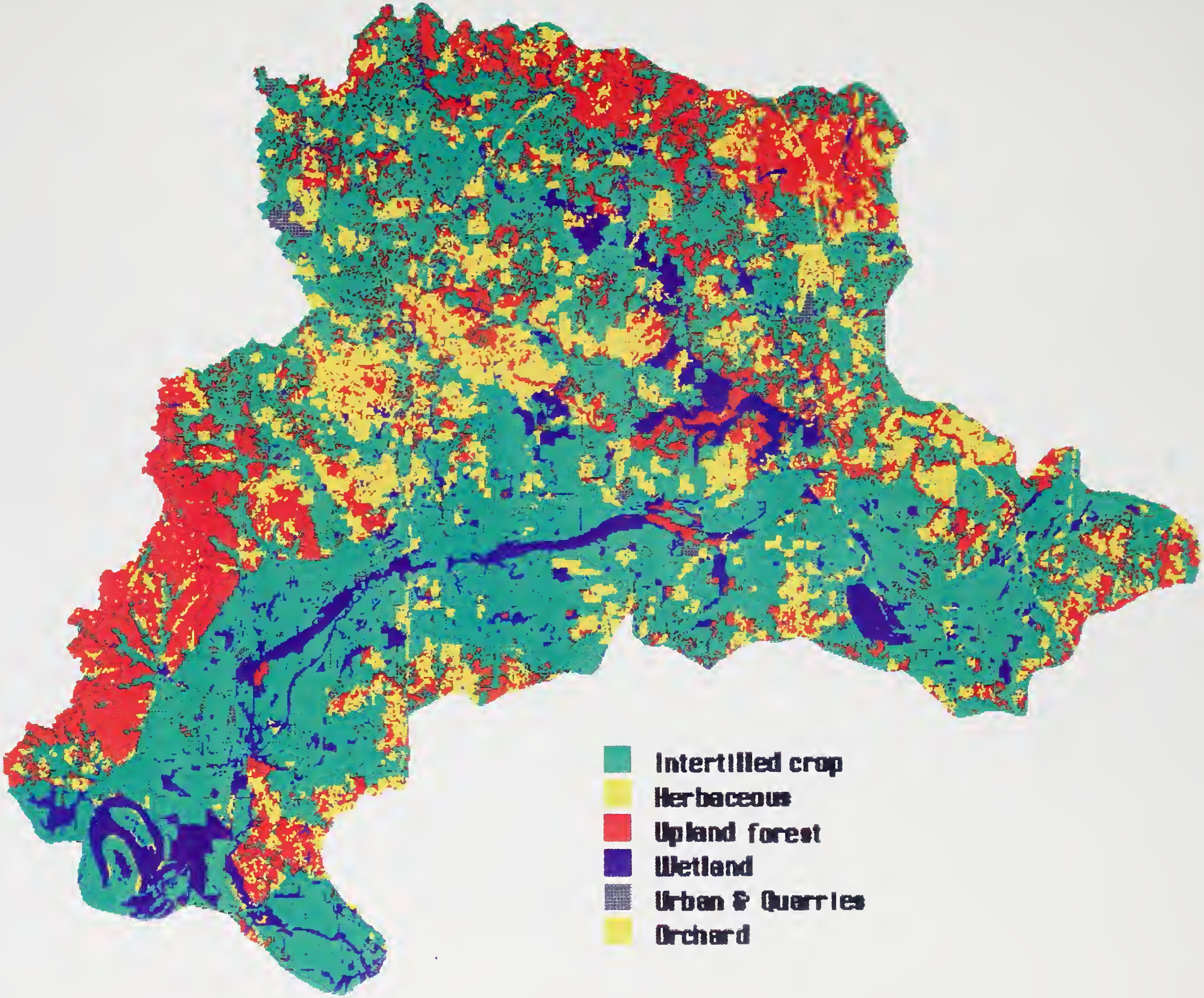
[c] Current land use patterns.

[d] Anticipated landscape after implementation of scenario 1 (natural community restorations within the core area).

[e] Anticipated landscape after implementation of scenarios 1 and 2 (establishing filter strips in riparian zones outside the core area.

Figure 7.

Land use/land cover of the Cache River watershed based on Landsat 5 Thematic Mapper imagery (August 1991) and the National Wetlands Inventory.


Intertilled crop
Herbaceous
Upland forest
Wetland
Urban & Quarries
Orchard

reflecting the predominantly rural environment of the watershed. About 13 percent of the watershed was in herbaceous cover that included idle early successional lands, pasture, and hay lands. Wetland habitats accounted for nearly 10 percent of the watershed area, consisting primarily of forested wetland and swamp. The wet meadow habitat type consisted mostly of temporarily to seasonally inundated wetlands in agricultural areas (wet crop fields, farmed wetlands). Most (92 percent) of the open pond wetland type consisted of artificially excavated or impounded basins.

Land use/land cover composition was similar between the upper and lower watersheds (Table 24). However, land use/land cover differed between the core and buffer areas. Most of the upland forest, row cropland, and herbaceous areas were located in the buffer area surrounding the core. Nearly half of the existing forested wetland area within the watershed was located within the core area boundary. Extant forest and wetlands habitats remaining within the core area were relatively disjunct and concentrated along the immediate floodplain of the lower Cache River (Figure 8).

Scenario 1: Core area restorations.--The core area, including Cypress Creek NWR, the interagency Joint Venture Area, and current state-owned lands totaled nearly 23,000 ha; 12 percent of the entire watershed (Table 25). The acquisition boundary of Cypress Creek NWR and Joint Venture Areas included larger proportions of row cropland and forested wetland and swamp, but

Table 24. Comparison of Current Land Use/Land Cover Among the Core, Buffer, and Stream Buffer Areas Within the Cache River Bioreserve in Southern Illinois in Hectares.

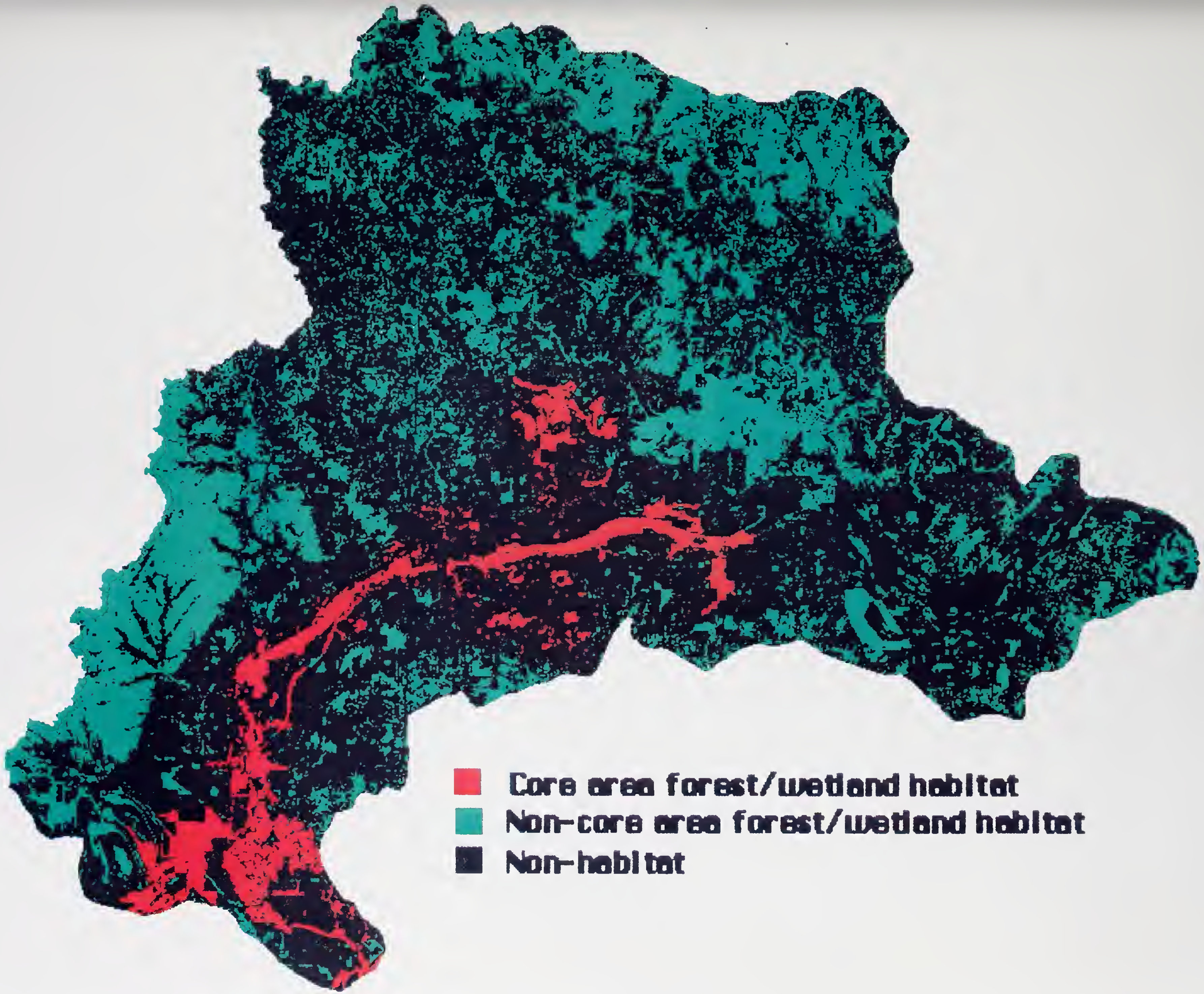
Bioresource Area	Upland Forest	Forested Wetland	Row Crop	Herb-aceous	Other	Total
Core Area						
State-owned	1,366	3,339	1,756	290	759	7,510
Cypress Creek NWR	1,103	3,066	9,470	553	985	15,177
Buffer Area						
Upper Cache	25,195	4,529	44,780	12,789	5,327	92,620
Lower Cache	21,421	3,381	38,449	11,474	4,356	79,082
Stream Buffers						
Upper Cache	4,892	1,671	6,198	1,287	675	14,723
Lower Cache	2,979	1,080	5,947	1,366	668	12,039
Watershed						
Upper Cache	26,216	5,919	45,067	12,985	5,397	95,584
Lower Cache	22,869	8,372	49,389	12,122	6,027	98,778
Total	49,085	14,291	94,456	25,105	11,424	194,362

Table 25. Current Land Use/Land Cover Within the Acquisition Boundary of Cypress Creek National Wildlife Refuge.

	Area	
Land Use/Cover Class	(Ha)	(Percent)
Lake	11.3	0.1
River/stream	107.6	0.7
Intermittent Stream	0.0	0.0
Ditch	55.4	0.4
Total aquatic	174.3	1.1
Open pond	134.5	0.9
Forested Wetland/Swamp	2,750.7	18.1
Shrub/Scrub Wetland	315.2	2.1
Marsh	29.5	0.2
Wet Meadow	384.5	2.5
Total Wetland	3,614.4	23.8
Upland Forest	1,102.8	7.3
Herbaceous	553.2	3.6
Orchard	0.0	0.0
Row Crop	9,470.2	62.4
Mine/Quarry	0.0	0.0
Roads	260.2	1.7
Urban	1.6	<0.1
Total Upland	11,388.0	75.0
TOTAL	15,176.7	99.9

Figure 8.

Current distribution of forest/wetland habitat in the Cache River watershed of southern Illinois. Based on reclassification of imagery depicted in Figure 5 to reflect conditions prior to implementation of habitat restorations within the core area of the bioreserve (Landscape 1).


Core area forest/wetland habitat
Non-core area forest/wetland habitat
Non-habitat

lower proportions of upland forest than was present in the entire watershed.

Restoration of natural forest and wetland communities within the core area will not reduce sediment deposition in wetlands of the lower Cache River. The buttonland swamp area currently acts as a trap for sediments that erode from uplands and stream systems outside of the core area (Demissie 1989). Much of the sediment deposited in this area is discharged by Big and Cypress Creeks. Although natural communities will be protected and restored within the watershed, they will continue to be threatened by degradation of water quality and sediment deposition from outside the core area.

The greatest ecological benefit of natural community restorations within the core area will be to increase the availability and quality of habitat for plants, fish, and wildlife. About 10 percent of Cypress Creek NWR is to be retained in row crop agriculture (Roelle and Hamilton 1992). Thus, land acquisition and habitat restorations planned for the core area could potentially convert about 8,000 ha of cropland to lowland and upland forest, prairie, and wetlands. Hydric soils cover about 66 percent of the acquisition area (U.S. Fish and Wildlife Service 1991), so there is potential to restore about 6,403 ha of wetlands. This would represent a 35 percent increase in wetland habitat across the entire watershed.

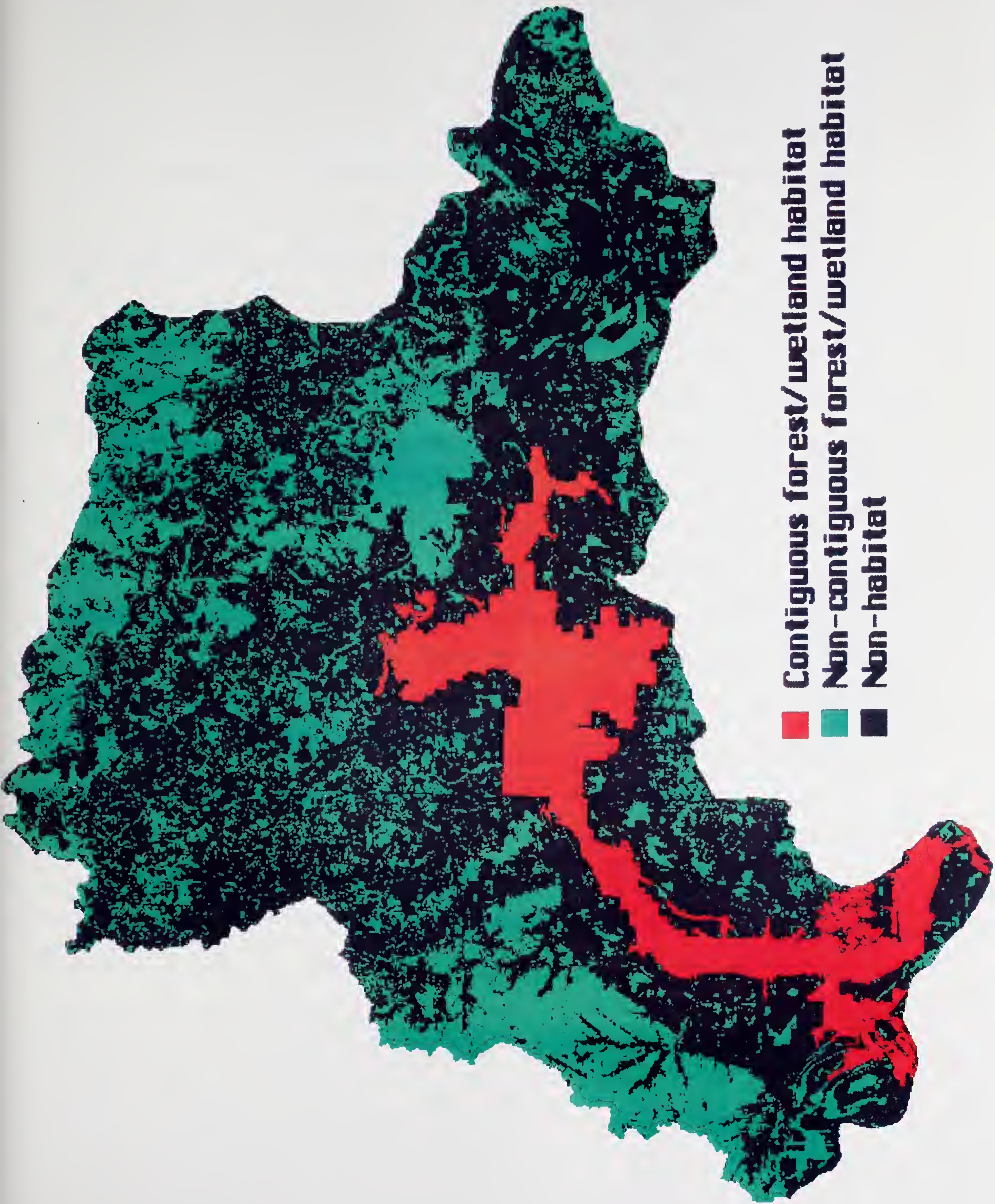
Assuming that 10 percent of the area to be left in row crop production and that areas currently classified as upland

forests are entirely located on non-hydric soils, there is potential within the core area to add about 2,500 ha of upland forest. Over time, forest restoration on uplands within the core area could contribute a 5 percent increase in forest cover within the entire watershed.

Habitat restorations within Cypress Creek NWR and the Joint Venture Area would cause substantial changes in the size, number, and connectivity of forest and wetland habitats within the watershed (Table 23, Figure 9). Land use changes resulting from this scenario link a number of previously disjunct and isolated patches to create a large block of forest and wetland habitat with a total area of about 23,000 ha. Acquisition and restoration of habitat in the core area will have ecological impacts that extend beyond the boundaries of the refuge and Joint Venture Area. However, overall connectivity among natural ecological communities within the still predominantly agricultural landscape would remain low. There would still be a large contiguous parcel of agricultural land, that exceeds 113,600 ha in size. Remaining parcels of habitat located on private lands, in the Shawnee National Forest, and on state-owned lands (Heron Pond, Little Black Slough State Natural Areas) would still be spatially disjunct and isolated from each other within the agricultural landscape.

Figure 9.

Anticipated distribution of forest/wetland habitat in the Cache River watershed of southern Illinois after implementation of scenario 2. Based on reclassification of imagery depicted in Figure 5 to reflect conditions after implementation of habitat restorations within the core area of the bioreserve (Landscape 2)


🟥 Contiguous forest/wetland habitat
🟩 Non-contiguous forest/wetland habitat
⬛ Non-habitat

Scenario 2: Filter strips.--Riparian zones (90 m wide) surrounding streams outside of the core area totaled nearly 27,000 ha, about 14 percent of the watershed. Current land use/land cover composition of riparian zones was remarkably similar between the upper and lower watersheds (Table 26). Potential filter strips (buffered areas) in the upper watershed contained lower proportions of row cropland (42 vs. 49 percent) and herbaceous cover (11 vs. 9 percent) and higher proportions of wetland (13 vs. 10 percent) and upland forest (33 vs. 24 percent) habitats. Forty-five and 52 percent of the areas within 30 - 45 m of intermittent and permanent streams in the lower and upper watersheds, respectively, are currently in some form of woody or herbaceous cover. Conversion of cropland to permanent vegetation cover along 90 m riparian zones of streams would remove about 5,900 and 6,200 ha of land from agricultural production in the lower and upper watersheds, respectively. Converting cropland to filter strips could potentially add about 12,000 ha of herbaceous or wooded vegetation cover to riparian zones outside of the core area.

Establishing permanent vegetation cover along riparian zones (filter strips) in the buffer area is projected to have a moderate impact on sediment deposition in swamps within the core area. A large proportion of sediment input to wetlands in the Lower Cache may now originate largely from bed and bank erosion within tributary streams. Much of this sediment may have been

Table 26. Current Land Use/Land Cover within 90 m Buffer Areas Along Riparian Corridors Outside of the Core Area in the Upper and Lower Cache River Watershed.

	Lower Cache		Upper Cache	
Land Use/Cover Class	(Ha)	(%)	(Ha)	(%)
Lake	3.2	<0.1	147.9	1.0
River/Stream	26.7	0.2	2.8	<0.1
Intermittent Stream	2.4	<0.1	0.8	<0.1
Ditch	0.0	0.0	0.0	0.0
Total Aquatic	32.3	0.3	151.5	1.0
Open Pond	87.4	0.7	88.2	0.6
Forested Wetland/Swamp	1,030.8	8.6	1,547.1	10.4
Shrub/Scrub Wetland	49.0	0.4	124.2	0.8
Marsh	4.0	<0.1	12.5	0.1
Wet Meadow	71.2	0.6	171.2	1.1
Total Wetland	1,242.4	10.3	1,943.2	13.1
Upland Forest	2,950.0	24.5	4,890.3	33.0
Herbaceous	1,366.6	11.4	1,287.3	8.7
Orchard	29.1	0.2	1.6	<0.1
Row Crop	5,946.6	49.4	6,197.9	41.8
Mine/Quarry	19.4	0.2	12.5	0.1
Roads	419.3	3.5	321.3	2.2
Urban	30.4	0.2	14.2	0.1
Total Upland	10,761.4	89.4	12,725.1	85.9
TOTAL	12,036.1	100.0	14,819.8	100.0

deposited from agricultural runoff that occurred when the watershed was more extensively farmed, and before soil and water conservation practices were widely implemented. Consequently, we project that establishing filter strips will only moderately reduce sediment input to the Lower Cache River.

Although a decline in sediment source material may occur with implementation of a given soil and water conservation practice, this does not always translate to an immediate decline in sediment load. Water entering the stream as runoff may not be carrying its capacity of sediment because of reduced availability of eroded soil. A decline in sediment source material entering a stream may cause resuspension of sediment stored within the stream bed and bank when previously high concentrations of sediment exceeded the transport capacity of the stream (Knox 1987, Trimble 1983). Resuspended sediment could add to sediment loads when stream flows do not carry their capacity of sediment. If this occurs, sediment load may increase after improvements in land management practices until streamflow has significantly reduced the amount of stored sediments available for remobilization.

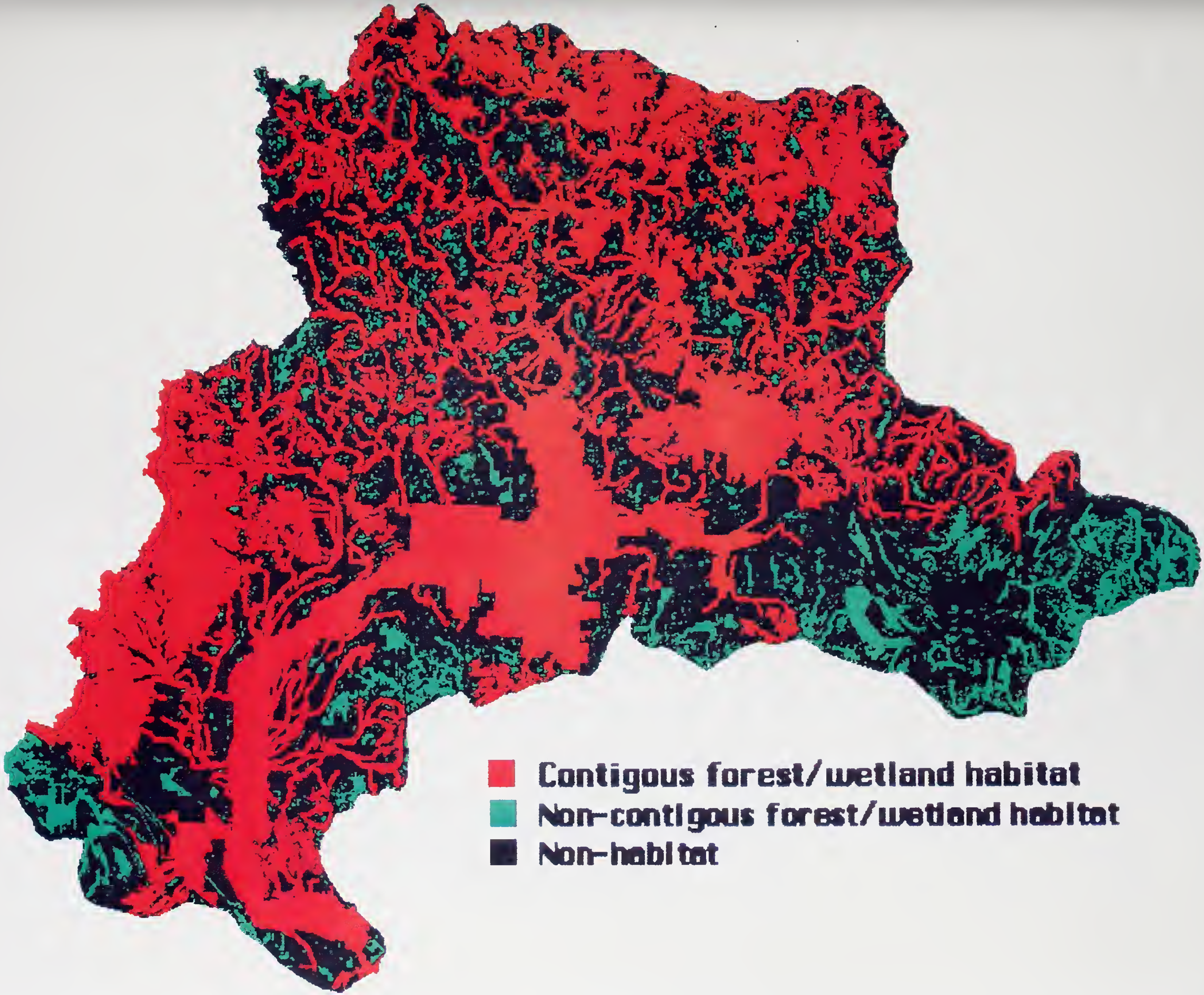
Implementation of filter strips could be an effective option in dealing with this phenomenon. Vegetated filter strips have proven effective in controlling sediment and nutrient loading by reducing the delivery of sediment and nutrients to the stream or water body. According to Karr and Schlosser (1978), the reestablishment of more natural near-stream vegetation and

channel morphology of an agricultural watershed can produce substantial improvements in water quality. Empirical (Phillips 1989) and simulation (Williams and Nicks 1988) data showing the effective use of filter strips to control runoff supports this statement. The riparian zone provides the greatest impact on delivery of sediments to a stream. The riparian zone's filtering effects, bank stabilization benefits, and flood storage capabilities provide a great advantage toward achieving water quality goals (Cooper et al., 1987; Lowrance et al., 1985; Lowrance et al., 1986; Menzel, 1983). Thus, we anticipate that filter strips will moderately enhance the biological integrity of riparian corridors, improve water quality, and thereby enhance habitat for plants, fish, and wildlife.

Reestablishment of natural riparian vegetation would also improve overall landscape connectivity within the watershed. Converting 13,000 ha of cropland to permanent vegetation along riparian zones outside the core area would further connect isolated fragments of forested and wetland habitats (Figure 10). Forest and wetland habitat parcels average 26 ha and maximum parcel size exceeds 77,000 ha. The agricultural/human component of the landscape component consists more of disjunct isolated parcels, with the largest nonhabitat parcel less than 16,000 ha in size. Under this scenario, the habitat has become the matrix in which agricultural and other developed lands are embedded, although the total area of nonhabitat declined by only 12 percent.

Figure 10.

Anticipated distribution of forest/wetland habitat in the Cache River watershed of southern Illinois after successive implementation of scenarios 1 and 2. Based on reclassification of imagery depicted in Figure 5 to reflect conditions after implementation of habitat restorations within the core area and establishment of filter strips within riparian zones located in the buffer area of the bioreserve (Landscape 2).


🟥 Contigous forest/wetland habitat
🟩 Non-contigous forest/wetland habitat
⬛ Non-habitat

Converting 13,000 ha of cropland to filter strips creates a network of interconnected habitats that encompasses over 80 percent of 93,755 ha of forest and wetland habitat. The network of buffer strips would connect blocks of habitat within Cypress Creek NWR and the Joint Venture Area, Little Black Slough, Horseshoe Lake and numerous tracts of private and federally-owned forest across the watershed. The majority of the land in the basin (52 percent) is still agricultural or other nonhabitat, but the filter strips would fragment this land into a series of smaller parcels.

Scenario 3: Highly erodible cropland.--Twenty eight percent of cropland in the Cache River watershed is classified as highly erodible; an additional 13 percent is considered potentially highly erodible (U. S. Soil Conservation Service 1987). Erodible croplands are generally upland soils on relatively steep slopes or crop field that lie within 30 m of streams or wetlands. Consequently, most of the highly erodible cropland lies outside of the core area. Davie (1991) examined the effects on sediment loads of Big and Cypress Creeks of converting highly erodible cropland to permanent vegetation cover during the first 3 years of the CRP. During that period, 16 and 26 percent of cropland within the Big and Cypress Creek catchments were enrolled in CRP, respectively. Davie (1991) estimated only 0.0125 percent and 0.265 percent reductions in measured in-stream suspended sediment loads of Big and Cypress Creeks during the 3 years at these levels of CRP enrollment. Thus, we anticipate that conversion of

highly erodible cropland to permanent vegetation cover would cause minimal reductions in sediment delivered to tributary streams. Davie (1991) estimated that for every 27 ha (1 percent) of cropland enrolled in CRP, there was a 9 kg reduction in sediment load per storm event in Big Creek. Every 1 percent (44 ha) of cropland enrolled in CRP in Cypress Creek would reduce sediment load by only 15 kg/storm event.

However, reductions in sediment load may increase with time as vegetation cover becomes better established. Additionally, much of the land area enrolled in CRP was located in areas distant from streams, and < 12 percent occurred within riparian zones of the Big and Cypress Creek catchments during 1986-88 (Davie 1991). There was a greater estimated reduction in sediment load in Cypress Creek, where a larger proportion of cropland was enrolled in CRP (26.5 vs. 15.6 percent) and a greater proportion of CRP was located within riparian zones (11 vs. 7 percent), compared to Big Creek. Based on these results, we project that unless large proportions of cropland are converted to permanent herbaceous cover, particularly in areas close to tributary streams (i.e. filter strips), implementation of this scenario will cause little reduction in sediment transport by tributary streams and deposition in wetland along the lower Cache River.

We anticipate that converting erodible cropland to forage production would likely produce only marginal improvement in wildlife habitat. Grassland species may benefit somewhat from

increased availability of herbaceous cover located in close proximity to cropland. However, these areas will likely be characterized by relatively monotypic stands of vegetation that are regularly mowed and/or grazed, thereby detracting from their value as wildlife habitat.

Digitized soil mapping unit and topography data with the necessary spatial resolution to adequately map erodible croplands across the entire watershed was not available. However, conversion of row cropland to permanent herbaceous cover would probably do little to reduce fragmentation or enhance connectivity of natural wetland or forest habitats because of the relatively low quality and location of areas likely to be converted to forage production.

Comparisons among scenarios.--The implementation of filter strips along streambanks and conversion of highly erodible cropland to permanent vegetative ground cover was considered in 2 of the 3 scenarios that we evaluated. These conservation practices are effective in reducing the supply of pollutants and sediments to a stream, as well as stabilizing existing stream banks. Justification for implementing such practices is based on the hydrologic relationships between precipitation, altered ground cover, topography, soil characteristics, and rainfall/surface storm runoff characteristics (Dunne and Leopold 1978, Foster et al. 1980). The combination of all these variables determines the availability and capacity to transport sediments to a stream. Only ground cover and to a lesser extent, topography, can be

altered to affect the availability and transport capacity of sediment. Terracing is an effective soil conservation practice that alters topography, however, economic benefits are sometimes questionable.

Increase rates at which erosion supplies sediment to a stream is associated with human activities that either increase the rate of runoff within the watershed or that impact soil stability. Poor land management practices are associated with increased rates of erosion and sedimentation. Thus, deforestation and cropping of highly erodible lands contribute to accelerating natural erosive processes (Knox 1987, Trimble 1983, Walling 1988). Lands with steep slope and fields adjacent to bodies of water that are intensively farmed were considered to be highly erodible and were the target of the scenarios considered here.

Ground cover, to varying degrees, has the capacity to reduce runoff by reducing the impact of precipitation droplets on the soil surface, and by directly absorbing moisture through leaves, stems and roots of vegetation. Thus, permanent woody and/or herbaceous cover provides greater potential to reduce the availability of sediment by reducing runoff than seasonal row crops (Dunne and Leopold 1978). This provides a barrier to overland flow and increases groundwater infiltration.

Theoretically, retiring highly erodible lands from crop production and restoring permanent vegetative cover should result in a reduction of overland flow, thereby reducing capacity to

transport eroded materials to bodies of water. Groundwater infiltration should increase, releasing water to streams at more gradual rates than through overland flow. Permanent vegetation cover along streamside lands (filter strips) should also trap a portion of sediment carried by overland and overbank flow to further reduce the delivery of sediments to the stream, as well as contribute to protecting the riparian zone from bank erosion (Clark et al. 1985). Filter strips would also provide the added benefit of reducing agricultural contaminants and nutrient burdens of water that does reach the stream system. Thus, we anticipate an overall improvement of water quality through implementation of filter strips.

The issue still remains that altered surface water drainage patterns have disrupted natural hydrologic regimes in the watershed. Channelization of major tributaries and diversion of streamflow from the upper watershed directly to the Ohio River facilitates sediment deposition in riparian wetlands associated with the Lower Cache River. Restoration of natural hydrologic regimes and control of sediment input to the Lower Cache River are essential components of ecological restorations. Restoration of channelized streams to their original channels may be more effective in reducing sedimentation by slowing flows, thereby reducing bed and bank erosion and allowing sediment to settle before entering core area swamps. Increased streamflow from the upper watershed to the Lower Cache River may be necessary to transport some of the sediment previously deposited in swamps,

and to restore natural hydrologic regimes.

It is highly unlikely that any land use change that alters ground cover to control erosion would increase stream velocity thereby increasing the stream's ability to transport sediment particles. Instead, we anticipate a decrease in transport power through a decrease in extreme peak flows and a more gradual rise and fall in the rate of runoff over time. This type of transformation should cause a reduction of transport power that would reduce stream sediment loads.

Although the highly erodible cropland scenario attempts to address the problems of erosion and sedimentation at their source, we anticipate little further improvement in these conditions beyond what may have already been accomplished with CRP and other soil and water conservation measures that have been implemented in the watershed. The land use classification revealed that much of the land located on relatively steep terrain within the more erodible soil associations is already in herbaceous cover.

Among the scenarios that we considered, filter strip establishment best addresses problems associated with sedimentation and water quality in the Cache River watershed. However, we do not believe that this scenario, even if implemented watershed-wide, addresses the entire problem of sediment deposition in wetlands along the lower Cache River. Hydrological modifications of the stream system that most closely restore natural flow patterns and water regimes to wetlands and

streams must be implemented to fully address problems associated not only with sediment deposition, but also bed and bank erosion through stream entrenchment. Consideration of such modifications is already underway (U.S. Army Corps of Engineers 1992).

Changing land uses associated with core area restorations and establishment of filter strips create fundamental changes in the organization of the landscape. Measures of these changes have been developed recently in the field of landscape ecology. From the perspective of landscape ecology, land use and land cover changes that increase the size of parcels of habitat are beneficial to plant and animal communities. Likewise, changes that decrease fragmentation of the habitat units in the landscape and increase connectivity between habitat units are desirable from an ecologic perspective.

Clearly, forest and wetland restorations within the core area will have the greatest impact on habitat within the watershed. Core area restorations will expand riparian habitats and connect fragments of remnant bottomland forest and swamp communities of the lower Cache River. Addition of Cypress Creek NWR and the Joint Venture Area increase the area of natural habitat by about 13,000 ha, and the size of the largest block of habitat from 9,200 ha to 22,700 ha. However, the refuge and Joint Venture Area do not connect numerous habitat units throughout the Cache River basin. The core area will still be isolated from other large tracts of bottomland forest and swamps that remain within the buffer area.

Filter strips, will add additional habitat to the watershed, and also connect many forest and wetland communities throughout the watershed. Land use changes resulting from successive implementation of scenarios 1 and 2, cause natural habitats to increase by about 26,000 ha, with a concomitant decrease in nonhabitat, primarily agricultural cropland.

In summary, scenario 1 (core area restorations) will create a large block of contiguous habitat that protects and expands the threatened wetland and swamp communities of the lower Cache River. These communities are still threatened by sediment deposition from soil and stream erosion that originates almost entirely outside of the core area. Actions are necessary outside of the core area to reduce sediment transport to wetlands and streams within the core. This can be accomplished with two general approaches; changing land use practices in riparian zones and on erodible cropland; and restoration of more natural surface water flow patterns and hydrologic regimes. The filter strip scenario has the greatest potential to affect water quality and sedimentation through changing land use; the erodible cropland scenario is expected to provide only marginal improvements. An integrated riparian habitat management program is needed that incorporates hydrological as well as vegetation restoration components.

Economic Assessment

IMPLAN results. Table 27 presents the economic impacts of the anticipated land use changes discussed above. We have selected three economic parameters to present: the change in the value of total sectoral output, the change in total personal income, and the change in employment. For illustration, we present the economic effects separately for three of the land use changes at the fifth year. The projected shift of land out of agricultural production into the joint-venture activities in the core area should cause a reduction in value of total economic output of $2.088 million, a reduction in personal income of $809 thousand, and a loss of 22 jobs. In contrast, the operation and maintenance of the visitor center and the other activities of the joint-venture partners in the core area should result in an increase of $1.951 million in total industrial output, a $830 thousand increase in personal income, and a gain of 26 jobs. Similarly, the projected recreational activities and the visitors to the area should result in an increase of total industrial output of $795 thousand, an increase in personal income of $304 thousand, and a net gain of 16 jobs. Taken together, the economic effects at the fifth year result in slight increases in total industrial output of $658 thousand, in personal income of $324 thousand, and in a net gain of 20 jobs.

Over the fifteen years we have projected in combination with an expansion of local entrepreneurial and business activity there could be an increase in total industrial output of $3.003

Table 27. Summary of Economic Impacts of Anticipated Land Use Changes in the Core and Buffer Areas of the Cache Bioreserve

	Economic Effect Level of Change		
Type of Impact[a]	Total Industrial Output ($MM)	Total Personal Income ($MM)	Employment (No. Jobs)
Agricultural Land Use			
5 years	(2.088)	(0.809)	-22
Operation and Maintenance of Visitor Center 5 Years	1.951	0.830	26
Recreational 5 Years	0.795	0.304	16
Combined Agricultural, Operation and Maintenance and Recreation			
5 years	0.658	0.324	20
10 years	0.942	0.395	37
15 years	3.003	1.201	96
Buffer Area Hunting Clubs			
5 years	0.233	0.097	6
10 years	0.614	0.254	15
15 years	1.335	0.550	33
Construction of Visitor Center Spread Over Construction Period	24.422	10.355	308
Filter Strips (Impact per 405 Ha)	(0.078)	(0.004)	-1
Big Creek (608 Ha)	(0.117)	(0.006)	-1.5
Cypress Creek (311 Ha)	(0.060)	(0.003)	-0.8
Cache River Watershed (12,145 Ha)	(2.340)	(0.120)	-30.0

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[a] Impacts cannot be accurately estimated for forage on highly erodible land given the IMPLAN structure of the cattle sector. Further hybridization of IMPLAN beyond the scope of this report is required

Source: IMPLAN Reports

million, and increase of $1.201 million in personal income, and a net increase of 96 jobs. Similar types of economic changes are projected to take place in the buffer area given the development of private hunting clubs. For example, at the end of the fifth year, we anticipate that these hunting clubs will cause a modest increase in total industrial output of $233 thousand, a small increase in personal income of $97 thousand, and an increase in employment of 6 jobs.

The construction of the visitor center will have a large but transitory impact on the economy of the region. The IMPLAN results suggest that over the construction period, the center will generate an increase of $24.422 million in total industrial output, an increase of $10.355 million in personal income, and a gain of 308 jobs.

Considered by itself, the establishment of filter strips along waterways in the Cache River basin will have a negative effect on the local economy. For each 405 ha. of land shifted from row crops to filter strips with forage, there will be a small reduction in total industrial output of $78 thousand, a small reduction in personal income of $4 thousand, and the loss of 1 job. As discussed above, the data and the structure of IMPLAN did not permit accurate projections of the economic effects of shifting highly erodible land from row crop production to forages.

SAAM results. In addition to the use of IMPLAN, we used the Small

Area Assessment Model (SAAM) to analyze the regional nature of the anticipated economic impacts. Given the economic structure of the economy of the region today, and the structure of the economy in the surrounding six counties, SAAM was used to predict the local economic effects of the establishment of the bioreserve in the five county region impacted as well as the surrounding six counties which have stronger and more diversified economic bases. These predictions are based on IMPLAN after computing the direct, indirect, and induced economic impacts of a shock to the economic system. In this case, we shocked the system in several ways: (1) the agricultural scenarios described above, (2) the operation and maintenance budget of $520,000 for wages and salaries, and $1.3 million dollars worth of annual expenditures for other purpose by the joint venture partners and (3) expected changes in recreation related expenditures by persons visiting the area. As a result of gradual changes taking place in both the agricultural sector (shift from row crops to forages and removal of land from agricultural production) and the recreational sector (increased visitor expenditure and participation), changes in the net impacts on the area's economy will be taking place.

Results from the SAAM model suggests that through time, a higher proportion of the net positive impacts of the establishment of the refuge will be experienced by the six county area surrounding the five counties of the Cache River watershed (Tables 28 through 31). By year five, the five county region

Table 28. Expected Agricultural, Operation and Management and Recreational Related Impacts on Sales, Employment, and Income, Due to Creation of Bioreserve, Year 5.

Area	Sales ($1,000)	Employment	Personal income by place of residence ($1,000)
Five County Impact Area			
Alexander	1,795	36	1,110
Johnson	800	9	548
Massac	1,642	18	1,094
Pulaski	358	4	270
Union	2,554	28	1,651
Five County Total	7,149	95	4,673
Six County Adjacent Area			
Jackson, IL	1,116	12	99
Williamson, IL	833	9	73
McCracken, KY	1,533	17	134
Ballard, KY	94	1	8
Mississippi, MO	165	1	15
Cape Girardeau, MO	1,555	17	136
Six County Total	5,296	57	465
Region Total	12,445	152	5,138

Source: SAAM Reports

Table 29. Expected Agricultural, Operations and Management, and Recreational Related Impacts on Sales, Employment, and Income Due to Creation of Bioreserve, Year 10.

Area	Sales ($1,000)	Employment	Personal income by place of residence ($1,000)
Five County Impact Area			
Alexander	1,301	29	214
Johnson	1,804	6	105
Massac	1,131	12	176
Pulaski	261	3	48
Union	1,804	20	285
Five County Total	6,301	70	828
Six County Adjacent Area			
Jackson, IL	1,519	17	140
Williamson, IL	1,119	12	103
McCracken, KY	2,119	23	191
Ballard, KY	114	1	11
Mississippi, MO	208	2	19
Cape Girardeau, MO	2,151	23	193
Six County Total	7,230	78	657
Region Total	13,531	148	1,485

Source: SAAM Reports

Table 30. Expected Agricultural, Operations and Management, and Recreational Related Impacts on Sales, Employment and Income Due to Creation of Bioreserve, Year 15.

Area	Sales ($1,000)	Employment	Personal income by place of residence (41,000)
Five County Impact Area			
Alexander	2,877	44	335
Johnson	1,367	15	174
Massac	2,565	28	306
Pulaski	585	7	78
Union	4,043	45	466
Five County Total	11,437	139	1,359
Six County Adjacent Area			
Jackson, IL	2,945	32	271
Williamson, IL	2,186	24	200
McCracken, KY	4,070	45	369
Ballard, KY	238	2	22
Mississippi, MO	423	5	39
Cape Girardeau, MO	17,380	190	1,603
Six County Total	27,242	298	2,504
Region Total	38,679	437	3,863

Source: SAAM Reports

Table 31. Economic Impact by Region of Agricultural and Related Effects, Operation and Maintenance of Core Area, and Recreational and Related Industries.

Area/Period	Sales of Goods and Services %	Employment %	Personal Income by Place of Work %
Five County Impact			
Year 5	57	63	91
Year 10	41	47	56
Year 15	30	32	35
Six County Adjacent Region			
Year 5	43	38	9
Year 10	59	53	44
Year 15	70	68	65

Source: SAAM Reports

will have a projected annual average increase of $7 million in total sales, an increase of 95 full time jobs, and an increase of $4.7 million of personal income (Table 28). By the end of the same period, the six counties surrounding the five counties of the bioreserve are expected to generate $12.5 in additional sales, 152 new jobs, and $5.1 million in personal income (Table 28). By the end of the initial five year period, the five county area has captured 57 percent of the new sales, 63 percent of the new employment, and 91 percent of the new personal income (Table 31).

Construction of the visitor center and the establishment of the joint venture activities in the core area results in a large portion of the initial dose of additional money being earned and expended in the region. Also, the gradual transition of land from row crop production to the bioreserve has dampened the negative regional impacts in this early period.

As time passes, the five county bioreserve area is expected to receive smaller and smaller shares of the new sales, employment and income generated as a result of the bioreserve (Tables 29 to 31). This is due to several interrelated factors. First, by the fifteenth year we expect much of the land conversion to be completed. This results in rather large negative impacts on the five county region, but results in rather minimal impacts on the six adjacent counties. Secondly, the positive impacts of the construction phase of the bioreserve have faded, and these benefits accrued almost exclusively to the five

county region of the bioreserve. Finally, by the fifteenth year, when visitor numbers and associated expenditures have increased to the point of having substantial positive feedback effects, we are not projecting sufficient development in the five county area to satisfactorily service these visitors. Hence, facilities in the surrounding counties capture most of the expenditures made by visitors to the bioreserve area.

This reflects the unavoidable conclusion that the region's economy is not sufficiently developed to take advantage of the expected spinoffs due to the establishment of the bioreserve. This can be viewed as the intractable problem of enhancing and promoting the region's economy solely through this activity. This is an integral feature confronting this region and a problem the region's residents must solve if it is to prosper and escape from some of the dreary statistics characterizing its economy. However, these data also suggest opportunities for market and business development. From the output of the SAAM model, it is obvious that as additional visitors are attracted to the area, those benefits will accrue to areas outside the five county bioreserve area. One of the reasons for this is the lack of existing facilities to serve the visitors and a limited capacity of the region to expand its offering of visitor services. However, if the opportunities of establishing a bioreserve with its attendant recreational activities are accepted as a challenge and integrated, realistic planning by all affected parties begins immediately, we believe that the bioreserve can in fact be a

significant stimulant to the economy of the region rather than a drag on it.

In summary, our analysis indicates that the Cache River region lacks the infrastructure necessary to supply the demands of nonresident visitors to the core area. Furthermore, the regional economy currently lacks the capacity to supply a high proportion of resident demand for goods and services. Consequently, the degree of interconnectedness among economic establishments in the region is low. The more sparse a region's economy is for a given level of change in a base sector (such as recreation), the less other business and household establishments are affected. If recreation is going to appreciably influence the economy in a positive way, marketing niches must be identified and economic activity generated to fill the demand in the niches. This will require forward, progressive thinking on the part of community leaders, and bold, risk taking initiatives by local investors and entrepreneurs.

CONCLUSIONS

Using ecological and land use analyses in conjunction with I/O modeling provides a useful basis for assessing effects of land use changes designed to protect ecological resources and to diversify a regional economy. Economic results combined with iterative assessment of ecological effects of land use changes provides a methodological framework for watershed planning and

predicting impacts of land use change on the regional economy. Projected changes in the economy can be used to determine if anticipated changes are acceptable to the human community. Concurrent ecological assessments provide analyses of the impact of land use changes on the quality of critical ecological resources. Results can be used to modify proposed land use changes so that ecological benefits and economic gains are maximized. Land use alternatives in the buffer area can be designed to provide the greatest ecological benefit. Our framework also provides a basis for assessing ecological and economic impacts of public policies that might be implemented within a predominantly rural watershed.

Results of our analysis (Table 32) indicate that the establishment of the core area without the development of a recreational component will have a positive effect on the development of habitat for wildlife and the restoration of ecological functions. However, due to the loss of agricultural production, it will have a negative effect on the economy. However, if, as the core area is established, resources are invested in the development of recreational facilities, (e.g., a visitor center, board walks, trails, etc.) the negative effects of the shift from agricultural production will be overcome and there will be a positive effect on the regional economy. Additionally, the establishment of the core area activities will result in the expansion of private hunt clubs in the buffer area which will further positively affect the economy.

Table 32. Projection of Overall Economic and Ecological Effects Associated with Alternative Land Use Scenarios and Other Development Activities Within the Cache River Bioreserve in Southern Illinois.

	Economic Impacts			Ecological Impacts		
Industrial Scenario/Activity	Output ($MM)	Personal Income ($MM)	Employment	Sediment	Habitat[a]	Landscape[b]
Core Area Restoration	-2.088	-0.809	-22	+Low	+High	+Moderate
Filter Strips						
Big Creek (608 Ha)	-0.117	-0.006	-1.0	+Moderate	+Low	+Low
Cypress Creek (311 Ha)	-0.060	-0.003	-0.8	+Moderate	+Low	+Low
Watershed (12,145 Ha)	-2.340	-0.120	-30.0	+Moderate	+Moderate	+High
Erodible Cropland	Low	Low	Low	+Low	+Low	None
Visitor Center[c]	1.951	0.830	+26	None	None	None
Recreation Development[d]	1.449	0.401	+22	None	-Low?	None

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[a] Anticipated change in availability of natural habitats (forest and wetlands) for fish and wildlife.

[b] Anticipated impact on connectivity and fragmentation of forest and wetland habitats across the watershed.

[c] Economic activity associated only with operation and maintenance over the first 5 years after construction.

[d] Includes recreation activities associated with the core area and private hunting clubs located in the buffer area.

The establishment of filter strips will result in positive ecological effects and, depending on the amount and location of the strips, will have minimal economic impacts. Primary ecological effects are in the areas of reducing sedimentation and other nonpoint source pollutants, increasing wildlife habitat, and increasing landscape connectivity.

In the near term, the conversion of highly erodible land from row crop production to forage production appears to have minimal ecological and economic impacts. However, over a longer time horizon, the conversion could contribute to a reduction in erosion and eventually sedimentation in the watershed.

Finally, given the sparse nature of the rural, regional economy and its lack of interconnectedness, without focused planning and investment, the economic benefits of the shift to a more recreationally based economy will be lost to the region. The additional economic activity derived from recreation will be captured by the counties surrounding the watershed.

A REPLICABLE FRAMEWORK FOR THE INTEGRATION OF ECOLOGICAL AND ECONOMIC CONCERNS IN LAND-USE PLANNING

ACKNOWLEDGEMENTS

NOTES

LITERATURE CITED

APPENDIX TABLES

A REPLICABLE FRAMEWORK FOR THE INTEGRATION OF ECOLOGICAL AND ECONOMIC CONCERNS IN LAND-USE PLANNING

The following is an outline for a replicable framework that can be used to formulate and evaluate alternative land-use scenarios and natural resource policies that are mutually compatible with preservation and restoration of ecological functions, and sustainable socio-economic development. The framework can be used to integrate ecological and economic parameters in resolving conflicts in use of land and natural resources by humans.

The following outline of the framework reflects the idealized experiences of the research team as it worked on the present project. A key element of the framework is the development of an interdisciplinary group of researchers that meets on a regular basis to discuss the research project and to explore the unique perspectives the different members of the team bring to understanding and analyzing the problem.

I. Specification of the problem. The framework begins with identifying the ecological problem(s) to be addressed through a change in land use and/or public policy affecting use of natural and/or human resources. Additionally, there is the need to determine what are the goals to be achieved through the process

of problem identification and designing of potential solutions. These problems can be placed into two broad, but not mutually exclusive categories (A and B). Once the problems are identified, a number of assessments must be made (C and D):

A. Ecological dysfunction. A disruption of basic ecological services that are essential to maintaining the ecosystem or ecological resources of the area. Or, a dysfunction that undermines the viability of the human community dependent on it.

B. Destruction or degradation of a unique natural ecological community or landscape component that is valued by some segment(s) of human society or that is of value in its own right.

C. Assessment of the regional, (e.g., local regional, state, national) and temporal, (e.g., present or how far out into the future?) scope of the goals.

D. Assessment of who is setting the goals and the criteria by which the goals are selected.

II. Describe the ecological and economic (human) systems that are impacted by the problem. Describe the nature of the impacts

including their temporal and spatial natures. Part of the description should focus on the functional role of the endangered ecological services in the ecosystem of which they are a part and the functional role they have in the human system.

A. Determine the direction and magnitudes of flow of raw materials, products, final goods and services, by-products(wastes), and services that are produced by ecological and economic systems elements of the landscape. This also captures the transformation of resources into goods and services through the economy.

B. Identify measurable parameters that indicate the current status, direction, and magnitude of change in the ecological and economic systems.

C. Identify qualitative parameters, when necessary, that indicate the current status, direction, and magnitude of change in the ecological and economic systems.

D. Identify criteria to use in assessing the level of the parameters identified in II-B and II-C. Also, determine the appropriate temporal and spatial scales for assessing the parameters. It is important to note that ecological factors might generate differential radiating rings of influence in

the ecosystem as opposed to the economy. These differential ecological, economic, social, and political effects must be identified and described.

E. Determine "protocols" to use in weighing the quantitative parameters and in "folding in" the qualitative parameters to arrive at an overall assessment of the problem.

F. Select or develop appropriate ecological and socio-economic models for the systems under study. Determine the strategies for modeling interactions between the ecological and economic aspects of the problems. This is based on the recognition that effective policy formulation affecting the use of natural resources is dependent upon input from the affected groups both inside and outside of the region of study (see IV below). Develop bases for assessing the reliability and validity of the models as descriptive and predictive tools as well as the data used by the models.

G. When necessary, collect the necessary "superior" data to "hybridize" or adjust existing models to reflect the actual economic and social conditions of the study area.

H. Assess the regenerative capacity of the ecological system and the capacity of the economic (human) system to change.

I. Assess the nature of the tradeoffs between the ecological and economic components of the systems being studied.

III. Determine the spatial domain of the problem.

A. Identify and locate the source(s) of the problem.

B. Determine the geographic extent of the problem within the socio-economic and ecological systems that are impacted.

C. Describe the current state and trajectory of change in ecological and economic systems under current conditions.

D. Identify the spatial congruencies between impacted economic and ecological systems. Given the nature of the problem, there might be multiple spatial scales relevant to the analysis of the ecological and economic aspects of the problem. At each scale, the relevant parameters and criteria must be determined as must the nature of the interaction among the ecological and economic components of the systems.

1. Determine how these systems interact and articulate with each other.

2. Identify points of mutual dependence between the ecological and economic systems.

3. Identify characteristics of ecological and economic systems and identify common areas where goals of economic and ecological integrity (sustainability) can be achieved.

IV. Identify the public policy domain of the problem and its institutional framework. Given the spatial and temporal dimensions of the problems that could be identified, it is necessary to also identify the relevant public policies at the local, state, and national levels that come to bear on the problems and their potential solutions. Not only is it necessary to identify the policies, it is also necessary to determine how the policies are being implemented and the set of rules and regulations that are informed by each policy. Furthermore, it is necessary to describe the institutional framework that influences what human actions actually take place. By institutional framework we mean the set of formal and informal groups of people affecting human actions in the regions as well as how these groups interact among themselves (Cohen 1991).

V. Identify alternatives. The alternatives encompass such things as land use changes or changes in productive technologies that underlie the economic system. These alternatives are to address

the problems initially identified given the information acquired above about the functioning of the ecological and economic systems and the nature of the interactions between the two.

VI. Determine the public and/or private policies necessary to accomplish each alternative. This also includes an assessment of the likelihood that new policies that are necessary to enable alternatives will be adopted.

VII. Assess alternatives. Using the material developed in III above, (e.g., parameters, criteria, protocols, and models) assess each alternative solution as to its ecological effects, its socio-economic effects, and the interactive effects. During this assessment, consideration must be given to the spatial effects of each alternative, the temporal effects of each alternative, and the conditions necessary to begin and sustain each alternative so it reaches its full potential. Things that need to be considered include weighing schemes for ecological and economic impacts/benefits, methods for considering qualitative changes. Use sensitivity analysis to assess the potential range of outcomes associated with each alternative.

VIII. Evaluate and validate the predicted consequences of each alternative.

IX. Establish a monitoring capability to determine if what was

thought would occur ecologically and economically as a result of the selected alternative actually does. This also includes a determination, if success can be attributed to the factors researchers projected to be critical or if success was do to something unforseen. Similarly, if there was no success, the factors leading to it must be determined (see Salamon 1979).

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NOTES

[1] The special tabulations were based on taking the zip code areas within the five county region and determining if more than 50 percent of a zip code area fill within the watershed. If 50 percent of more did fall in the watershed, it was classified as being part of the watershed. A computer program to manipulate the census records from the five-county region was then written and provided to the Census Bureau. The results we are presenting are based on these special tabulations.

SUGGESTIONS FOR A SECOND ROUND OF ECOLOGICAL-ECONOMIC MODELING AND APPLICATIONS IN THE CACHE RIVER BIORESERVE

Based on the work conducted for this report and the needs of the area and of the modeling activity, we have a number of suggestions for additional modeling and the applications of ecological-economic concepts in the Cache River Bioreserve. The following suggestions are not in any rank ordering:

(1) Use the soft systems approach a la Checkland (1981) to assess the acceptability to residents of the region of identified land uses changes and other economic activities for the area. This would permit us to identify a range of possible economic activities in the watershed that appear to be compatible with the ecological goals of preserving biodiversity and the economic goals of enhancing economic activity while being supported by the local population.

The soft systems approach is basically iterative resting on direct interaction with the people involved (e.g., landowners, land users, farmers, agency personnel, conservation groups). The interaction can be the result of focus groups, interviews with a range of people living in the region, or group meetings. The approach rests on the assumption that human systems are very messy and ill defined in terms of goals etc. Hence optimization is not a relevant concept. Rather, human systems and the people in them seek "improvement." Consequently, it takes time and effort to uncover the basic goals of the human groups involved and to identify communalities among the different groups. Given

that the use of resources within the Cache River watershed is in large part a human-based system, Checkland's ideas are applicable to revealing the goals of the various groups functioning in the area and the extent to which different land use scenarios are acceptable to them.

Based on systems concepts, we can bring the ecological, the economic, and the "human" aspects of the bioreserve together. This approach also provides a mechanism for moving out of the university and into the human communities in the area who are using the resource base.

This soft-systems approach could give us the basis to address one of the issues we have discussed earlier: anything you do to an area will have positive, negative, or no effects in terms of the environment and the economy. Of concern to us, is what is of basic ecological and economic interest in the area and from whose perspective? Is it wetlands, cypress swamp and the associated wetlands with their unique and threatened communities? Or, is it economic development? Or, is it the potential for economic development in such a way that the goal of biodiversity and maintenance-enhancement of ecological integrity is possible?

(2) Work on the development of ecologically based constraints on economic decision making by firms (e.g., farms, hunt clubs). The key here seems to be the operationalizing of ecological functions and processes in terms relevant for decision making. An example is alternative land uses specified by soil

type and the use of the Universal Soil Loss Equation or the Revised Universal Soil Loss Equation to show how the level of soil loss changes with different combination of crops and tillage. This could be tied into sediment transport models to help in studying sedimentation in the watershed. Another example is using SCS's data on soil type and the potential for chemical leaching or surface movement to constrain agricultural land use. Additionally, we could assess the impact of changing the hydrology associated with the Post Creek Cutoff.

We can assess the economic impacts of alternative land uses using farm-level data within a linear programming framework in which ecological concerns serve as constraints on the farm as do the mix of allowable agricultural practices. The allowable mix of agricultural practices would be determined based on ecological/economic criteria. Data from such linear programming models could be used to analyze the impact of proposed changes in agriculturally based land uses that would protect the environment given some set of ecological criteria. (Given other research projects of the investigators, a number of basic linear programming models exist that could be used in Cache River area.) Given the results of the linear programming, the development of sectors for the regional economy could proceed. This would take place with the IMPLAN model. That is land uses could be studied on the farm level. Acceptable land uses from ecological and economic perspectives could then be assessed regarding their impact on the regional economy and the region's ecology.

Additionally, parts of potential development strategies could be assessed and evaluated by possible users. Enhanced linkages among ecological and economic/social aspects of the watershed must also be carried out.

(3) Continue the development of GIS data base with historical data (land use data and environmental data derived from old air photos, soil surveys etc), process and/or functionally based ecological data, and cultural-economic data. Continue to develop the interface of GIS with ecological and economic data in order to examine spatial relationships among ecological and economic processes.

(4) Continue the hybridization of the input-output model with work on the agricultural (e.g, underlying farm enterprises and technology -- a shift away from the traditional chemical monoculture of row crops in the area) and recreational sectors (e.g., the capacity of the region to provide recreational infrastructure and to absorb recreational activities without endangering the very aspects of the area that attract people or without damaging the critical ecological resources).

(5) Continue the work on the underlying ecological models used in the analysis and their integration with the regional input/output modeling. Work on the development of "ecological sectors" for the IMPLAN model.

(6) Proceed with the development/application of ecological models relevant to the area. Explore integrating the ecological and economic flows and processes in ways that deal with the issues of spatial and temporal links within relevant landscape frames of reference.

(7) Start the development of a framework for assessing the regenerative capacity of the "eco-system" and impact of regeneration on ecological flows and the range of potential economic activities. Developp a realistic natural communities restoration template that projects long-term ecological changes.

LITERATURE CITED

Batisse, Michael. 1982. "The Biosphere Reserve: A Tool for Environmental Conservation and Management." *Environmental Conservation*. 9: 101-111.

Beck, Roger J. Kim S. Harris, Steven E. Kraft and Michael J. Wagner. 1990. "Potential Economic Impacts of the Proposed Cypress Creek National Wildlife Refuge." Appendix M in: *Cypress Creek National Wildlife Refuge: Environmental Assessment.* Fort Snelling, MN: U.S. Department of the Interior. Fish and Wildlife Service.

Bendavid-Val, Avrom. 1991. *Regional and Local Economic Analysis for Practitioners*. 4th ed. New York: Praeger.

Bledsoe, Lex. 1993. Instructor Plant and Soil Science Department SIU-C. Personal Conversations.

Burde, John H. and Gary Howatt. 1993. *Marketing Nature Centers: Product, Price, and Promotion*. Legacy. (In press).

Carr, B.A. 1980. "A Profile of the Commercial Agriculture." In *Farm Structure -- Historical Perspective on Changes in the Number and Size of Farms*. Committee on Agriculture, Nutrition, and Forestry, U.S. Senate. Washington, DC: U.S. Government Printing Office.

Checkland, Peter. 1981. *Systems Thinking, Systems Practice*. Chichester, UK: John Wiley and Sons.

Clark, E.H. II, J.A. Haverkamp, and W. Chapman. 1985. *Eroding Soils: The Off-Farm Impacts*. Washington, D.C.: The Conservation Foundation.

Clawson, Marion and Jack L. Knetsch. 1966. *Economics of Outdoor Recreation*. Baltimore: Johns Hopkins Univ. Press. Resources for the Future. 328 pp.

Cohen, Mark. 1991. *Principles of Institutionalist Research Methodology*. A.E. Staff 91-11. Ithaca, NY: Department of Agricultural Economics, Cornell University.

Cooper, J.R., J.W. Gilliam, R.B. Daniels, and W.P. Robarge. 1987. "Riparian Areas as Filters for Agricultural Sediment." *Soil Science Society of America Journal* 51:416-420.

Davie, D. K. 1991. "Assessment of the impact of the

Conservation Reserve Program on suspended sediment load in two southern Illinois Streams." M.S. Thesis, Department of Geography, Southern Illinois University at Carbondale.

Demissie, M., T. W. Soong, R. Allgire, L. Keefer, and P. Makawski. 1990. *Cache River Basin: hydrology, hydraulics, and sediment transport--Volume 1: Background data collection and analysis*. Illinois State Water Survey Section Contract Report 484. Urbana, IL: Illinois State Water Survey.

Demmissie, M. 1989. *Sediment Yield and Accumulation in the Lower Cache River*. Champaign, IL: Illinois State Water Survey.

Dunne, T. and L.B. Leopold. 1978. *Water in Environmental Planning*. New York: W.H. Freeman and Company.

Esling, S. P., W. B. Hughes, and R. C. Graham. 1989. "Analysis of the Cache Valley deposits in Illinois and implications regarding the late Pleistocene-Holocene development of the Ohio River Valley." *Geology* 17:434-437.

Forman, R.T.T. and M. Godron. 1986. *Landscape Ecology*. New York: John Wiley and Sons.

Forman, R.T.T., and M. Godron. 1981. "Patches and structural Components for a Landscape Ecology" *Bioscience* 31:733-740.

Foster, G.R., L.J. Lane, J.D. Nowlin, J.M. Laflen, and R.A. Young. 1980. "A Model To Estimate Sediment Yield From Field-sized Areas: Development of Model." In *CREAMS: a Field Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems*. United States Department of Agriculture Conservation Research Report 26. Washington, DC: USDA.

Gingrich, Chris, Robert H. Hornbaker and David C. White. 1991. *Crop and Livestock Budgets*. Illinois Cooperative Extension Service Publication AE-4683. Urbana, IL: University of Illinois, Dept. of Agricultural Economics.

Gittinger, J. Price. 1982. *Economic Analysis of Agricultural Projects*, 2nd Ed. Baltimore, MD: The Johns Hopkins University Press.

Gregory, G. Robinson. 1972. *Forest Resource Economics*. New York: Ronald Press. 548 pp.

Hill, D. B. 1985. "Forest Fragmentation and Its Implications in Central New York." *Forest Ecology and Management* 12:113-128.

Hiscock, John W. 1986. "Protecting National Park System Buffer

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Zones: Existing, Proposed, and Suggested Authority." Journal of Energy Law and Policy 7: 35-93.

Illinois Department of Conservation. n.d. Outdoor Recreation: Local Needs. Division of Planning, Springfield, IL: IL Dept. of Conservation.

Illinois Department of Conservation. 1989a. Illinois Outdoor Recreation: the 1989 Survey. Division of Planning.,Springfield, IL Dept.of Conservation. 19 pp.

Illinois Department of Conservation. 1989b. The Illinois Outdoor Recreation Plan: 1988-1993. 110 pp.

Illinois Department of Conservation. 1991. Open Spaces.... Family Places. 32 pp.

Jenkins, Robert E. n.d. "The Bioreserve Concept." unpublished paper -- mimeo. Arlington, VA: The Nature Conservancy. 29 pp.

Karr, J.R. and I.J. Schlosser. 1978. "Water Resources and the Land-Water Interface." Science 201: 229-234.

Kirkby, M.J. 1980. "The Problem." In Soil Erosion, ed. Kirkby and Morgan. New York: John Wiley & Sons.

Knox, J.C. 1987. "Historical Valley Floor Sedimentation in the Upper Mississippi Valley." Annals of the Association of American Geographers 77: 224-244.

Kovacic, D., K. Konyha, M. David, and L. Osborne. 1993. "Grassed Retention Buffer Strips for Reducing Agricultural NPS Pollution form Tile Drainage Systems." paper presented at Research on Agriculture Chemicals in Illinois Groundwater: Status and Future Directions III, a conference Sponsored by the Illinois Groundwater Consortium, 31 March - 1 April 1993, Makanda, IL.

Lacefield, Garry D. and Jimmy C. Henning. 1990. Forage News. Kentucky Cooperative Extension Service. Lexington, KY: University of Kentucky.

Lower Mississippi Delta Development Commission. 1990. Final Report: the Delta Initiatives. Memphis, TN: Lower Mississippi Delta Development Commission.

Lowrance, R., R. Leonard, and J. Sheridan. 1985. "Managing Riparian Ecosystems to Control Nonpoint Pollution." Journal of Soil and Water Conservation 40: 87-91.

Lowrance, R., J. K. Sharpe, and J. M. Sheridan. 1986.

"Long-term Sediment Deposition in the Riparian Zone of a Coastal Plain Watershed." Journal of Soil and Water Conservation 41: 266-271.

Maas, R.P., M.D. Smolen, and S.A. Dressing. 1985. "Selecting Critical Areas for Nonpoint Pollution Control." Journal of Soil and Water Conservation 40: 68-71.

Machlis, Gary E. and David L. Tichnell. 1987. "Economic Development and Threats to National Parks: a Preliminary Analysis." Environmental Conservation 14: 5-155.

McCurdy, Dwight R. 1992. A Study of Owners of Large, Private, Forested Tracts in Southern Illinois, 1977-1985-1991. Department of Forestry, Southern Illinois University, Carbondale, IL. 18 pp.

McPherson, Alan. 1993. Fifty Nature Walks in Southern Illinois. Vienna, IL: Cache River Press, 299 pp.

Menzel, B.W.. 1982. "Agricultural Management Practices and the Integrity of Instream Biological Habitat." Journal Paper No. J-10555 of the Iowa Agriculture and Home Economics Experiment Station, Project No. 2410. Ames, IA: Iowa State University.

Miller, Ronald E. and Peter D. Blair. 1985. Input-Output Analysis: Foundations and Extensions. Englewood Cliffs, NJ: Prentice-Hall.

Missouri Department of Conservation. 1989. Economic Benefits of Waterfowl Hunting at Duck Creek Wildlife Area. Public Profile 3-89. Jefferson City, MO: Missouri Department of Conservation.

Moore, Kevin C. 1991. Farm Management Newsletter: 1990 Missouri M.I.R. Crop Costs and Projected 1992 Crop Budgets. FM 91-2. Columbia, MO: Cooperative Extension Service, USDA, University of Missouri.

Morgan, R.P.C. 1980. "Implications." In Soil Erosion, ed. Kirkby and Morgan. New York: John Wiley & Sons.

Morgan, R.P.C. 1980. "Conclusion." In Soil Erosion, ed. Kirkby and Morgan. New York: John Wiley & Sons.

Noss, Reed F. 1992. "The Wildlands Project." Wild Earth. (Special Issue - 1992): 10-25.

Osborn, C. Tim, Felix Llacuna, and Michael Linsenbigler. 1992. The Conservation Reserve Program: Enrollment Statistics for Signup Periods 1-11 and Fiscal Years 1990-92. ERS

Statistical Bulletin 843. Washington, DC: USDA Economic Research Service.

Peterjohn, W.T. and D.L. Correll. 1984. "Nutrient Dynamics in an Agricultural Watershed: Observations on the Role of Riparian Forests." Ecology 65: 1466-1475.

Phillips, J.D. 1989. "An evaluation Of The Factors Determining The Effectiveness Of Water Quality Buffer Zones." Journal of Hydrology 107: 133-145.

Phillips, J.D. 1989. "Fluvial Sediment Storage in Wetlands." Water Resources Bulletin 25: 867-873.

Pike, John. 1993. Personal Conversations, graduate student Department of Agribusiness Economics, Southern Illinois University Carbondale, and former Field Representative for GrowMark.

Robinson, Dennis P. and James G. Hickman,III. 1990. "Local Area Economic Effects of Exporting Coal through Mobile Harbor's Turning Basin and Anchorage: A Small Area Assessment." unpublished paper. Fort Belvior, VA: Army Corps of Engineers, Institute for Water Resources.

Roelle, J. E., and D. B. Hamilton. 1992. Cypress Creek National Wildlife Refuge Biological Concept Plan. Fort Collins, CO: U.S. Fish and Wildlife Service, National Ecology Research Center, . 32 pp.

Salamon, Lester M. 1979. "The Time Dimension in Policy Evaluation: The Case of the New Deal Land-Reform Experiments." Public Policy 27: 129-183.

Slater, Courtenay M. and George E. Hall. editors .1992. 1992 County and City Extra: County and City Data Book. Lanham, MD: Bernan Press.

Schlosser, I.J. and J.R. Karr. 1981. "Riparian Vegetation and Channel Morphology Impact on Spatial Patterns of Water Quality in Agricultural Watersheds." Environmental Management 5: 233-43.

Schonewald-Cox, Christine M. and Jonathan W. Bayless. 1986. "The Boundary Model: A Geographical Analysis of Design and Conservation of Nature Reserves." Biological Conservation 38:305-322.

Schwegman, J. 1973. The natural divisions of Illinois. Rockford,IL: Illinois Nature Preserves Commission, 32 pp. plus map.

Schwegman, John. 1991. "Saving the Cache". Outdoor Highlights 19(9): 3-11.

Sharpe, D. M., G. R. Guntenspergen, C. P. Dunn, L. A. Leitner, F. W. Stearns. 1987. "Vegetation Dynamics in a Southern Wisconsin Agricultural Landscape. Pp. 137-155 IN M. G. Turner (ed) Landscape Heterogeneity and Disturbance. New York: Springer-Verlag.

Soil and Water Conservation Society. n.d. "Vegetative Filter Strips: Now Eligible for CRP Enrollment -- Consider the Advantages." brochure. Ankeny, IA: Soil and Water Conservation Society.

Soil Conservation Service, USDA. 1987. Cache River Basin: Erosion and Sedimentation Report. Carbondale, IL: Soil Conservation Service.

Suloway, L., M. Hubbell, and R. Erickson. 1992. Analysis of the wetland resource of Illinois. Volume I. Overview and general results. Draft Report, Springfield, IL: Illinois Department of Energy and Natural Resources. 25 pp. plus figures.

Swanson, Ernst W. 1969. Travel and the National Parks. USDI National Park Service. 40 pp.

Trimble, S.W. 1983. "A Sediment Budget for Coon Creek Basin in the Driftless Area, Wisconsin, 1853-1977." American Journal of Science 283: 454-474.

Turner, M. G. and R. H. Gardner (eds.) 1991. Quantitative Methods in Landscape Ecology. New York: Springer-Verlag.

UNESCO, MAB Secretariat. n.d. Biosphere Reserves. Paris: The MAB Secretariat, Div. of Ecological Sciences, UNESCO.

University of Minnesota. 1989. Micro Implan Software Manual. St. Paul, MN: University of Minnesota, Dept. of Agricultural and Applied Economics.

U. S. Army Corps of Engineers. 1992. Alexander and Pulaski Counties, Illinois Draft Reconnaissance Report. U. S. Army Corps of Engineers, St. Louis District. St. Louis, MO: U.S. Army Corps of Engineers. 67 pp. plus 9 appendices.

U.S. Census Bureau, Census of Agriculture. 1993. "Special Tabulations of the 1987 Census of Agriculture for Southern Illinois." Computer Output. Washington, DC: U.S. Bureau of the Census.

U.S. Department of Agriculture, Economic Research Service. 1992.

Agricultural Resources: Cropland, Water, and Conservation -- Situation and Outlook Report AR-27. Washington, DC: USDA Economic Research Service.

U.S. Department of Agriculture. Forest Service. 1992. Report of the Forest Service - FY 1991. Washington, DC: USDA Forest Service, 130 pp.

U.S.Department of Interior. National Park Service. 1985. Trail of Tears National Historic Trail. Draft National Trail Study. Southeast Regional Office. Atlanta, GA.

U. S. Fish and Wildlife Service. 1990. Cypress Creek National Wildlife Refuge Environmental Assessment. U. S. Fish and Wildlife Service, Region III. Fort Snelling, MN: U.S. Fish and Wildlife Service. 236 pp.

Walling, D.E. 1988. "Erosion and Sediment Yield Research-Some Recent Perspectives." Journal of Hydrology 100: 113-141.

Whitney, G. G. and W. J. Somerlot. 1985. "A Case Study of Woodland Continuity and Change in the American Midwest" Biol. Conserv. 31:265-287.

Whitton, Richard M. 1992a. Canada Goose Harvest and Hunter Activity in the Southern Illinois Quota Zone During the 1991 Season. Springfield, IL:Illinois Department of Conservation, Division of Wildlife Resources, n.p.

Whitton, Richard M. 1992b. A 5 - Year Comparison of Hunter Use and Harvest on Public Waterfowl Areas in Illinois, 1984-1988. Springfield, IL: Illinois Department of Conservation, Division of Wildlife Resources, n.p.

Williams, R.D. and A.D. Nicks. 1988. "Using CREAMS to Simulate Filter Strip Effectiveness In Erosion Control." Journal of Soil and Water Conservation 43: 108-112.

APPENDIX TABLES

Appendix Table 1-a Proposed Forage Enterprise Budget (Per Acre)

Revenue		**Estab.**	**Maint.**	**4 yr. avg.**
Production[1] (tons)		2	3	2.75
Receipts[2] @$	$75	$150.00	$225.00	$206.25
Variable Costs		**Estab.**	**Maint.**	**4 yr. avg.**
Seed		$30.00	n/a	$7.50
Fertilizer P[3]		$17.60	$6.89	$9.57
Fertilizer K		$17.50	$17.50	$17.50
Boron		$6.92	$6.92	$6.92
Application		$4.00	$4.00	$4.00
Lime		$8.00	n/a	$2.00
Application		$4.00	n/a	$1.00
Herbicide		$13.66	n/a	$3.42
Insecticide		n/a	$7.50	$5.63
Machinery: Fuel, Oil & & Misc. expense		$30.00	$30.00	$30.00
Labor		$9.00	$9.00	$9.00
Interest		$3.00	$3.00	$3.00
Total Variable Costs		**$143.68**	**$84.81**	**$99.53**
Fixed Costs		**Estab.**	**Maint.**	**4 yr. avg.**
Mach: Deprec., Taxes, housing, Insurance		$16.50	$16.50	$16.50
Land Rent		$50.00	$50.00	$50.00
Total Fixed Costs		**$66.50**	**$66.50**	**$66.50**
Total Costs		**$210.18**	**$151.31**	**$166.03**
		=====	=====	=====
Profit		**($60.18)**	**$73.69**	**$40.22**

---

[1] Gingrich, 1992

[2] See Table 2

[3] For more details on fertilizer costs see Table 3

Appendix Table 1-b Minnesota Sales and Auctions - Results past 5 seasons

Grade and Price relationship - from "Forage News" Fall 1990

University of Kentucky Extension Service.

Grade	# of lots	Avg. Pr./ton[4]
Prime	130	$131.10
1	395	$111.26
2	444	$76.27
3	231	$52.50
4	90	$43.92
5	22	$42.30
Tot./Avg.	1312	$85.26

It is important to note that product quality is the determinant of price. Also, to capture and maintain the targeted market (horse farms near Lexington KY.) hay quality must remain high.

Average of the top three grades (to the nearest $).	$98

Transportation cost was estimated to be $2.00 per loaded mile[5].

Truck capacity was taken as 15 tons per load[6].

The targeted market is approximately 175 miles from the production area.

The transportation cost per ton (to the nearest $).	$23
The adjusted farm price per ton is then	$75

---

[4] Data from Gingrich (1990).

[5] Conversations with Darrell Brink

[6] Ibid

Appendix Table 1-c Fertilizer Requirements for Alfalfa Hay

Based on a yield of 2 tons per acre the first year, and a yield of 3 tons per acre the next 3 years. Also, fertilizer requirements reflect the average soil fertility for region.

Nutrient	Soil Test (first year)	Buildup (lbs./acre)	Maintenance (lbs./acre)
Phosphorus (P_2O_5)	30	92[7,8]	36
Potassium (K_2O)	240	150	
Boron	n/a	3	
Lime (tons/acre)	6.0	2	n/a

Fertilizer	Price/ton	Buildup (tons/acre)	Cost ($/acre)	Maintenance (tons/acre)	Cost ($/acre)
Triple Phosph. (0-46-0)	$176.00[9]	0.100	$17.60	0.039	$6.89
Potash (0-0-60)	$140.00	0.125	$17.50	0.125	$17.50
Boron (14.3%)	$660.00	0.010	$6.92	0.010	$6.92
Application (of above)	n/a	n/a	$4.00	n/a	$4.00
Lime	$4.00	2.000	$8.00	n/a	n/a
Application (of above)	n/a	n/a	$4.00	n/a	n/a
Total cost per acre			$58.02		$35.31

4 Year Average $40.99

---

[7] Establishment fertilizer is defined as the general maintenance fertilizer plus a small amount in addition to the maintenance to aid in the development of the crop.

[8] Fertilizer requirements were established from Gingrich, and conversations with John Pike.

[9] All fertilizer prices were updated using prices obtained from a local area supplier.

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